User's Guide

High Compliance Current Source
LDX-3232

ILX Lightwave®
A Newport Corporation Brand

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SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

Safety Information and the Manual

Throughout this manual, you will see the words *Caution* and *Warning* indicating potentially dangerous or hazardous situations that, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

Caution indicates a potentially hazardous situation that can result in minor or moderate injury or damage to the product or equipment.

Warning indicates a potentially dangerous situation that can result in serious injury or death.

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained (see the contact information on page xiii).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page xi for more information.

SAFETY SYMBOLS

This section describes the safety symbols and classifications.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class I Equipment (grounded type)
- Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0°C to 40°C
- Storage and transportation temperature of -40°C to 70°C
- Maximum altitude: 3000 m (9843 ft.)
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations that can result in death, injury, or damage to the instrument and other components.

Caution, refer to manual	Earth ground Terminal	Alternating current	Visible and/or invisible laser radiation

Caution, risk of electric shock	Protective Conductor Terminal	Caution, hot surface	Frame or chassis Terminal
or (I) On: In position of a bistable push control. The slash (I) only denotes that mains are on.		or (O) Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.	

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to use of the product for that it was not intended**.**

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages**.**

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

1. Obtain a Return Authorization number (RA) from ILX Customer Service.
2. Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number from the rear panel of the instrument.
3. Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
4. Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. **Shipping damage is not covered by this warranty.**
5. Secure the packing box with fiber reinforced strapping tape or metal bands.

6 Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.

If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, thatever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone . . . . . (800) 459-9459 or (406) 556-2481

Fax . . . . . (406) 586-9405

Online FAQ: . . . . . www.ilxlightwave.com

Or mail to:

ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771
www.ilxlightwave.com

When you contact us, please have the following information:

Model Number: _____

Serial Number: _____

End-User Name: _____

Company: _____

Phone: _____

Fax: _____

Description of what is connected to the ILX Lightwave instrument: _____

Description of the problem: _____

If ILX Lightwave determines that a return to the factory is necessary, you are issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument

in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

We look forward to serving you even better in the future!

CHAPTER 1

INTRODUCTION AND SPECIFICATIONS

This chapter is an introduction to the LDX-3232 High Compliance Current Source. This chapter contains first time setup information, important safety considerations, maintenance information, instrument specifications, and general LDX-3232 information.

WARNING

If any of the following symptoms exist, or are even suspected, remove the LDX-3232 from service. Do not use the LDX-3232 until trained service personnel can verify safe operation.

Visible damage
Severe transport stress
Prolonged storage under adverse conditions
Failure to perform intended measurements or functions

If necessary, return the LDX-3232 to ILX Lightwave for service and repair to ensure that safety features are maintained.

Product Overview

The LDX-3232 instrument is a high compliance laser diode current source intended for use with quantum cascade laser diodes and other devices requiring a high compliance output. The LDX-3232 current source provides a high stability output with multiple laser protection features and a fully redundant current limit. The LDX-3232 offers the added benefits of dual laser interlocks and a GPIB interface to allow full automation of testing.

Initial Inspection

When you receive your LDX-3232 instrument, verify that the following items were shipped with the instrument:

- LDX-3232 High Compliance Current Source
- LDX-3232 Series Instruction Manual
- Power Cord
- Shipping Kit

Installing Your LDX-3232 High Compliance Current Source

Grounding Requirements

The LDX-3232 High Compliance Current Source comes with a three conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact or two-contact adapter with the grounding wire connected to an electrical ground (safety ground). The LDX-3232's power jack and supplied power cable meet IEC safety standards.

AC Line Power Requirements

You can operate the LDX-3232 instrument from a single phase power source delivering nominal line voltages of 100, 120, 220-240 VAC (all values RMS), at 50/60 Hz. The line power voltage can vary ±10% but cannot exceed 250 VAC. Maximum power consumption is 60 VA (Volt-Amps). The instrument's operational voltage is factory configurable and need not be changed before operating the instrument. However, check to be sure that the voltage printed on the back panel of the instrument matches the power-line voltage in your area.

Before connecting the LDX-3232 High Compliance Current Source to a power source, verify that the AC power source matches the setting of the LDX-3232's voltage printed on the rear panel of the instrument.

To avoid electrical shock hazard, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury or death.

GPIB Connector

The IEEE 488 GPIB interface connector is located on the rear panel, directly above the power input module and fuse. See Figure 1.2, LDX-3232 Rear View. Attach the GPIB cable to the 24-pin connector located on the rear panel. The connector is tapered to ensure proper orientation. Using your fingers, tighten the two screws on the cable connector.

A total of 15 devices can be connected together on the same GPIB interface bus. The cables have single male/female connectors on each end so that several cables can be stacked. This allows more than one cable to be attached to any one device. However, the maximum length of the GPIB cables must not exceed 20 meters (65 feet) total or 2 meters (6.5 feet) per device.

The GPIB Address

The talk and listen addresses on the LDX-3232 High Compliance Current Source are identical. This GPIB address is read locally by pressing the (GPIB) LOCAL switch with the address displayed on the LED display. The instrument comes from the factory configured with the GPIB address set to 1. You can change the LDX-3232's GPIB address locally (via front panel). A procedure for changing the address can be found in the section "Changing the GPIB Address" in Chapter 3.

Tilt-Foot Adjustment

The LDX-3232 High Compliance Current Source comes standard with folding front legs and two rear feet for use as a bench top instrument. Extending the front feet so that the instrument front panel sits up makes it easier to view the LED displays. To use them, place the unit on a stable base and rotate the front legs downward until they lock into position.

Operating the LDX-3232 Precision Current Source

Now that the LDX-3232 High Compliance Current Source is installed and ready for use, you can begin to learn about its operation. The following photos show the functional keypad groupings, back panel connectors, and so on. Use these figures to familiarize yourself with the LDX-3232. After that, use Chapter 2 for fundamentals of operating your instrument.

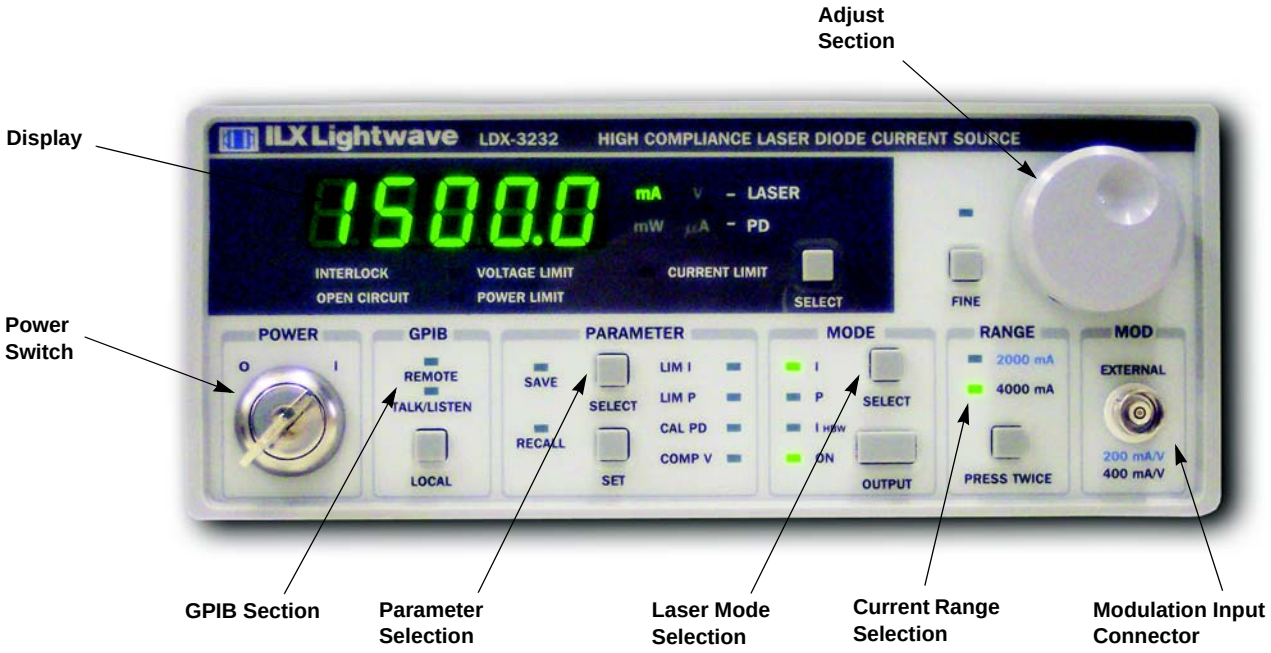


Figure 1.1 LDX-3232 Front View

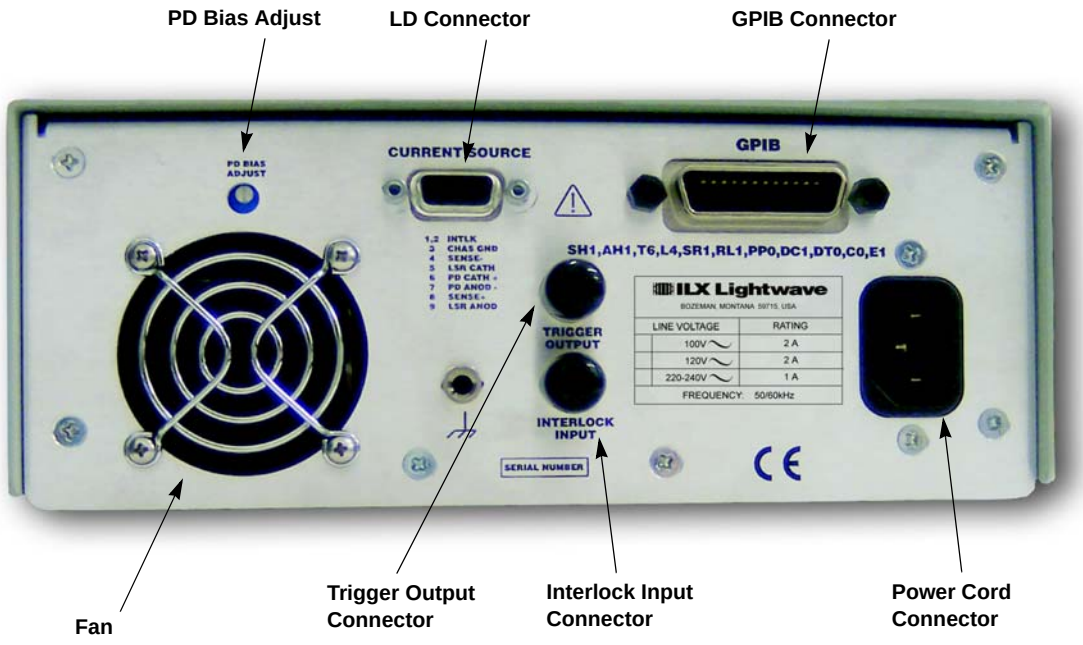


Figure 1.2 LDX-3232 Rear View

Maintenance

You may have to return your instrument to the ILX Lightwave facility at some time for repair or service whether or not it is under warranty. There is a charge for repairs after the warranty period has expired. Contact an ILX Lightwave service representative for shipping instructions prior to returning the instrument. Have the model number, instrument serial number, and a description of the problem or request at the time of the call. All ILX Lightwave instruments are identified by a serial number located on the rear panel. The first four or five digits are the model number; the last four digits are unique to the instrument and identify your instrument specifically. A return authorization number will be given to you at the time of your request for repair or service. Please use this number in all communications concerning your instrument.

If you need to ship your LDX-3232 High Compliance Current Source back to the factory for repair, be sure that the LDX-3232 is packaged in an enclosure with cushioning material to prevent damage to the instrument during shipment (use the original shipping containers and accessories if possible). Re-install the ESD protective caps on the rear and front panels over the connectors (9 pin D, BNC, and GPIB). Shipping damage is not covered under warranty.

Attach a tag to the instrument identifying the owner and indicating the service or repair needed. Include the model number and serial number. We suggest that you insure the shipment.

In North America, contact ILX Lightwave for return authorization and shipping instructions. Outside of North America, contact your ILX distributor for shipping information.

For more information on how to obtain repair services, see the Safety and Warranty section of this manual.

If cleaning is required, use a clean dry cloth. Do not use solvents.

WARNING

Potentially lethal voltages exist within the LDX-3232 High Compliance Current Source. To avoid electric shock, do not perform any of the maintenance on the instrument unless you are qualified to do so. Qualified service personnel are required to wear protective eyeglasses and anti-static wristbands while working on the LDX-3232 High Compliance Current Source circuit boards. High voltages are present on and around the instrument's printed circuit boards.

Specifications

	LDX-3232	
Drive Current Output[1]		
Output Current Range	0 to 2000 mA	0 to 4000 mA
Setpoint Resolution[2]	40 µA	80 µA
Setpoint Accuracy	±0.15% of SP ±2 mA	±0.15% of SP ±2 mA
Compliance Voltage	0 - 15 V, adjustable	0 - 15 V, adjustable
Temperature Coefficient	<100 ppm/°C	<100 ppm/°C
Short Term Stability (1 hour)[3]	<20 ppm	<20 ppm
Long Term Stability (24 hours)[4]	<40 ppm	<40 ppm
Noise and Ripple (µA rms)[5] High Bandwidth Mode Low Bandwidth Mode	 <20 µA <20 µA	 <40 µA <20 µA
Transients Operational[6] 1 kV EFT/Surge[7]	 <4 mA <8 mA	 <4 mA <8 mA
Compliance Voltage Adjust		
Range	0 - 15 V	0 - 15 V
Resolution	10 mV	20 mV
Accuracy	±20%	±40%
Drive Current Limit Settings		
Range	1 to 2020 mA	1 to 4040 mA
Resolution	10 mA	20 mA
Accuracy	±20 mA	±40 mA
Photodiode Feedback		
Type	Differential	Differential
PD Reverse Bias	0 - 5V, adjustable	0 - 5V, adjustable
PD Current Range	5 to 10,000 µA	5 to 10,000 µA
Output Stability[8]	±0.02%	±0.02%
Accuracy, setpoint (% of FS)	±0.05%	±0.05%
External Analog Modulation		
Input	0 - 10 V, 1 kΩ	0 - 10 V, 1 kΩ
Transfer Function	200 mA / V	400 mA / V

	LDX-3232	
Bandwidth (3 dB)[9] High Bandwidth Low Bandwidth	 DC to 250 kHz DC to 10 kHz	 DC to 250 kHz DC to 10 kHz
Trigger Output		
Type	TTL	TTL
Pulse Width	13 µs	13 µs
Delay	12 ms	12 ms
Measurement (Display)		
Output Current Range	0 to 2000.0 mA	0 to 4000.0 mA
Output Current Resolution[10]	0.1 mA	0.1 mA
Photodiode Current Range	0 to 10,000 µA	0 to 10,000 µA
Photodiode Current Resolution	1 µA	1 µA
Photodiode Current Accuracy	±4 µA	±4 µA
PD Responsivity Range[11]	0.00 to 1000.00 µA/mW	0.00 to 1000.00 µA/mW
PD Responsivity Resolution	0.01 µA/mW	0.01 µA/mW
Optical Power Range	0.00 to 5000.0 mW	0.00 to 5000.0 mW
Optical Power Resolution	0.1 mW	0.1 mW
Forward Voltage Range	0.000 to 10.000 V	0.000 to 10.000 V
Forward Voltage Resolution	1 mV	1 mV
Forward Voltage Accuracy[12]	±2 mV	±2 mV
General		
Size (H x W x D)	4” x 8.5” x 13.4”; 102 mm x 216 mm x 340 mm	
Weight	~ 20 pounds (9 kg)	
Power	100/120/230-240 V~; 2/2/1A 50/60 Hz	
Temperature	0°C – 40°C operating; -40°C – 70°C storage	
Humidity	< 90% relative humidity, non-condensing	
Laser Safety Features	Key switch, interlock and output delay (meets CDRH US 21 CFR 1040.10)	
Display Type	5-digit, green LED	

Notes

1. All values relate to a one-hour warm-up period at room temperature, 25°C.
2. Based on resolution of digital-to-analog converters used in the design.
3. Over any 1-hour period, half-scale output.
4. Over any 24-hour period, half-scale output.
5. Measured electrically with a 1 ohm load at half-scale output; evaluating spectral noise density over a 150kHz bandwidth from 125kHz to 275 kHz.
6. Maximum output current transient from normal operational situations (e.g., power on-off, current on-off), as well as accidental situations (e.g., power line plug removal).
7. Maximum output current transient resulting from a 1000 V power-line transient spike. Tested to ILX Lightwave Technical Standard #LDX-00196.

8. Maximum monitor photodiode current drift over any 30 minute period. Assumes zero drift in responsivity of photodiode.
9. 50% modulation at mid-scale output. Higher bandwidth is possible with smaller magnitude modulation signal.
10. Similar resolution available over GPIB.
11. Responsivity value is user-defined and is used to calculate the optical power.
12. Four wire voltage measured at the load. Voltage measurement accuracy while driving calibration load. Accuracy is dependent upon load and cable used.

Available Options and Accessories

Options and accessories available for the LDX-3232 High Compliance Current Sources include the following:

DESCRIPTION	MODEL NUMBER
Noise Filter	LNF-320
Current Source Interconnect Cable (terminated)	CC-305S
Current Source Interconnect Cable (unterminated)	CC-306S
DIL Laser Diode Mount	LDM-4982
Butterfly Laser Diode Mount	LDM-4894
High Power Laser Diode Mount	LDM-4442
Single Rack Mount Kit	RM-139
Dual Rack Mount Kit	RM-140

Other laser diode mounts are available. Please contact ILX Lightwave for information on additional options for your application.

Our goal is to make the best laser diode instrumentation available anywhere. To achieve this, we need your ideas and comments on ways we can improve out products. We invite you to contact us at any time with your suggestions.

CHAPTER 2

OPERATION

This chapter introduces you to the operation of the LDX-3232 High Compliance Current Source. It offers instructions for connecting your laser to the current source and describes powering up the instrument. This chapter also contains step by step procedures that teach you how to operate your current source in Constant Current Mode and Constant Power Mode. We recommend that you review the contents of this chapter at a minimum before operating the LDX-3232 Current Source.

Applying Power to Your LDX-3232

To turn on the LDX-3232, rotate the key in the "POWER" section of the front panel from "O" to "I". This action will initiate the power on sequence. If the LDX-3232 does not appear to turn on, verify that it is connected to line power. If line power is not the problem, remove the power cord and check the voltage selection block in addition to the line power fuse.

The Power On Sequence

During the power-up sequence, the following takes place. For about three seconds all indicators light up, and all of the 7-segment displays indicate "8". Then all lamps are turned off for three seconds. Next, the firmware version will be displayed. Then, a self-test is performed to ensure that the instrument's hardware and processor are communicating. After this test, the instrument is ready to operate and is configured to the state it was in when the power was last shut off.

The Power On State

You can choose to "clear" the last saved state by recalling the default values. These values are stored in BINS to that you can save or recall instrument configurations (described in more detail in Chapter 5). "BIN 0" contains all of the default configurations listed in Table 2.1.

Note: If the instrument cannot successfully complete the power on test, an error message of E-512 or E-513 will be displayed on the Display. See Chapter 3 for a list of error codes and actions to take when your instrument indicates these errors.

Table 2.1 LDX-3232 Default Settings

GPIB mode in LOCAL via front panel, or in REMOTE via GPIB
PARAMETERS not selected
CAL PD = 0 µA / mW
LIM I (high range) = 1000 mA
LIM I (low range) = 500 mA
LIM V = 15 volts
LIM P = 5000 mW
Output off
DISPLAY enabled, in I mode
Constant I, low bandwidth mode selected
I setpoint = 0 mA
I_{PD} setpoint = 0 µA
P_{PD} setpoint = 0 mW
RECALL BIN number = 0

Connecting to the Laser

When connecting your laser to the LDX-3232, we recommend that the instrument be powered up with the output off. In this condition, a low impedance shunt is active across the output terminals. When disconnecting devices, it is only necessary to turn the current source output off.

It is also recommended that the connections to the LDX-3232 output be made using twisted wire pairs with an earth-grounded shield (see Figures 2.1 - 2.4). The output terminals of the instrument are left floating relative to earth ground to suppress AC power-on/power-off transients that may occur through an earth-ground path. If the output circuit is earth-grounded at some point (such as through the laser package and mount), the user must be careful to avoid multiple earth

grounds in the circuit. Multiple earth grounds may provide circuit paths that induce spurious currents in the photodiode feedback circuit and output leads.

Note: Cable connections to the laser must be secure! Loose connections can cause momentary open circuits that can damage the laser.

Figures 2.1 - 2.4 show the possible configurations of connecting laser diodes and photodiodes with the LDX-3232 High Compliance Laser Current Source.

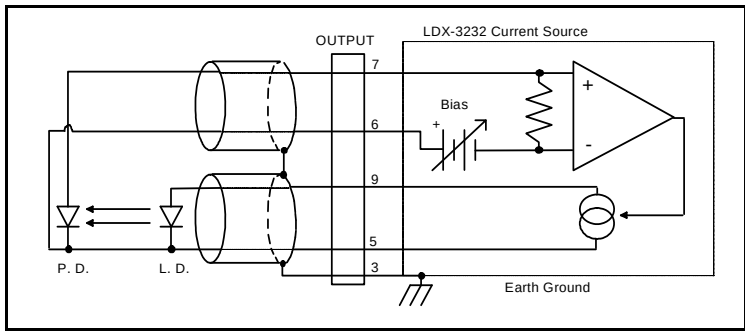


Figure 2.1 Common Laser Cathode - Photodiode Cathode

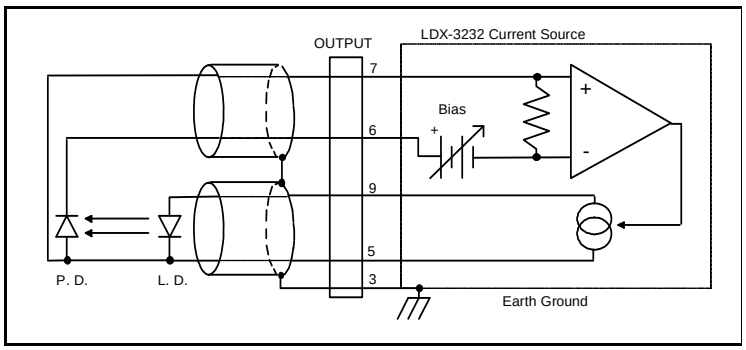


Figure 2.2 Common Laser Cathode - Photodiode Anode

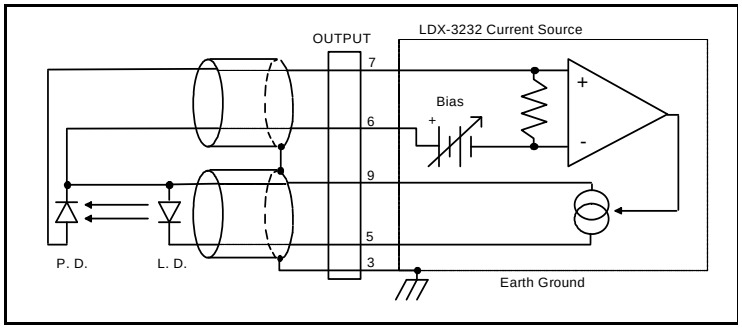


Figure 2.3 Common Laser Anode - Photodiode Cathode

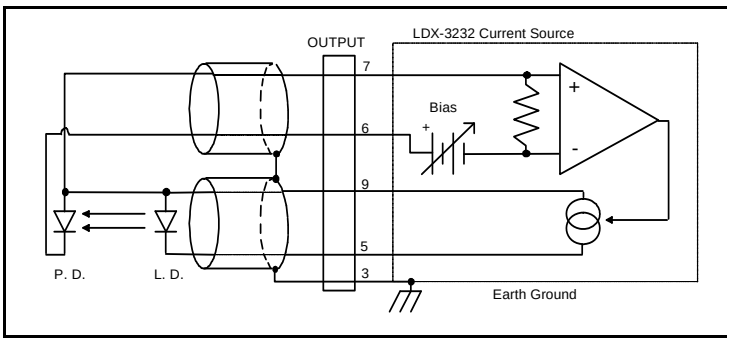


Figure 2.4 Common Laser Anode - Photodiode Anode

The 9-pin connector marked CURRENT SOURCE on the back panel is used to connect your laser diode to the LDX-3232. There are connections provided for laser cathode and anode, photodiode cathode and anode, chassis ground and interlock. The pinout diagram for this connector is shown in Figure 2.5.

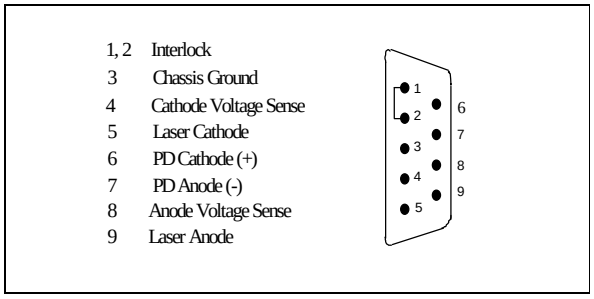


Figure 2.5 Back Panel LD Connector

Interlock Connections

In order for the laser output to be enabled a short circuit must exist between the Interlock Pins (Pins 1 and 2) of the connector. The short can be a direct short across the pins or a switch to prevent laser operation until the switch is closed. If a short does not exist between these two pins, the INTERLOCK LED will illuminate on the front panel and the laser output will be disabled.

Note: The BNC Interlock Connection from the BNC connector on the rear panel will also make the INTERLOCK LED illuminate. Please see the notes in chapter five on use of the BNC interlock connection to learn more about its operation.

CAUTION

The interlock terminals on the LASER connector, pins 1 and 2, must be kept isolated from all other connections including earth ground.

Photodiode Connections

Many laser diode modules contain an internal photodiode that monitors the back-facet emission of the laser. Usually, this photodiode is internally connected to either the laser anode or cathode.

The photodiode and laser connections to the LDX-3232 are electrically isolated from ground and each other. So, if a 4 pin connection is made (no common connections), no additional jumpers are required. Figures 2.1 - 2.4 show the recommended connections and shielding for 3-pin lasers (where the common connection is internal to the device). A 4-pin laser should be connected with the same shielding as shown in Figure 2.1, but the common connection (between the photodiode and the laser) is optional.

Setting the PD Bias

The LDX-3232 provides an adjustable reverse bias of 0-5 VDC for the photodiode. To set the photodiode bias to 5 V reverse bias, turn the back panel PD BIAS ADJUST fully clockwise. To set the photodiode bias to 0 V reverse bias, turn the back panel PD BIAS ADJUST fully counter-clockwise.

Grounding Considerations

The LASER outputs of the LDX-3232 High Compliance Current Source are isolated from chassis ground, allowing either output terminal to be grounded at the user's option. Figures 2.1 - 2.4 show the proper earth-ground shielding for laser diode/photodiode connections.

Front Panel Operation

This section describes fundamentals of operation for your LDX-3232 in two operating modes: Constant Current (I) and Constant Power (P).

The Display

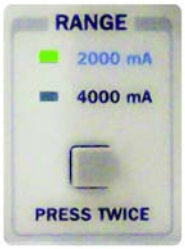
The digital display is used to show control parameters such as laser drive current (mA), laser current limit (mA), laser forward voltage (V), voltage limit (V), monitor photodiode current (µA), and laser optical power (mW) in both setpoint and measurement modes. It will also display error codes that relate to LASER operation. Error indicators underneath the display indicate control errors and are explained in the section titled “ERROR INDICATORS”. All laser control parameters are displayed on this digital display with the appropriate annunciator illuminated.

Operating a Laser in Constant Current (I) Mode

Suppose you have an LDX-3232 and you want to run the instrument in Constant Current, low bandwidth mode, with a setpoint of 1500 mA and a current limit of 1750 mA. This particular mode uses a low-pass filter on the laser drive current output to significantly reduce noise. In this mode a modulation input of up to 10 kHz may be used via the front panel MOD EXTERNAL connector. Follow the instructions below in the sequence presented.

Setting Up the Precision Current Source

Set the LDX-3232 in Constant Current, low bandwidth mode by selecting I in the MODE section of the front panel. Do this by toggling the SELECT push button until the I indicator is illuminated. Repeatedly pressing the (MODE) SELECT switch cycles through the current (I), light power (P), or high-bandwidth current (I_{HBW}) control modes.



Next, in the RANGE section set the current source range by selecting the 2000 mA range indicated by the accompanying LED. You will need to press the SELECT push button twice to change the range. It must be pressed twice quickly (within less than 1 second) to switch between ranges, and the LASER output must be off (LASER MODE ON indicator unlit) in order to change ranges.

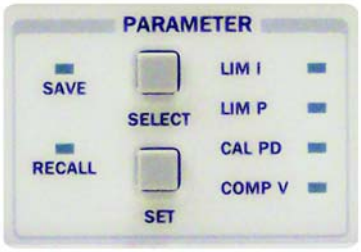
Configure the display so that it reads laser current in mA. Press and release the SELECT switch in the DISPLAY section of the front panel until the mA annunciator is lit. The (DISPLAY) SELECT switch is also used to select the I_{PD} (PD current, µA), P_{PD} (laser power, mW), or V (forward voltage, V) measurement or setpoint display modes. When the setpoint mode is active, the corresponding annunciator will flash to indicate setpoint rather than measurement display.

To only view the setpoint, press and hold down the display SELECT switch for two or more seconds. When the SELECT switch is released the previous measurement mode will be restored.

At this point the LDX-3232 is in Constant Current Mode, (I), in the 2000 mA range, and the display is reading in mA. Next, we need to adjust the setpoint of the laser current source.

To adjust the setpoint of the current source to 1500 mA, turn the adjust knob to vary the setpoint. When the adjust knob is turned, the LDX-3232 automatically changes to setpoint mode indicated by the flashing annunciator. Adjust the setpoint to 1500 mA. After an adjustment has been made, and the adjust knob is released, the setpoint mode will time out in three seconds. The display will revert to the original measurement display mode (I, I_{PD}, V, or P_{PD}).

The instrument is still not ready to turn on the laser. One of the laser protection features our precision current sources offer is a fully independent hardware current limit. The current limit protects your laser by never allowing the laser drive current to exceed the limit independent of the setpoint and the output control mode (Constant Current or Constant Power).



To set the current source limit, use the SELECT push button in the PARAMETER section of the front panel to select LIM I. Press the (PARAMETER) SET push button and rotate the adjust knob to vary the limit setpoint value. After three seconds, the new parameter value is stored in non-volatile memory.

When the LASER current limit is reached, the CURRENT LIMIT error indicator flashes. The current limit setting is independent of the voltage drop of the device connected to the LASER output, and therefore, no dummy load is required for precise adjustment of the current limit. Furthermore, since the current limit circuitry is fully independent of the main current control, the current limit can be adjusted safely, even while the LASER output is active.

An additional feature of the LDX-3232 instrument is an adjustable voltage limit. This allows an extra level of laser protection in the event of an intermittent open circuit. For maximum protection via the fastest open-circuit detection, the voltage limit should be set to a value slightly greater than the intended operating voltage.

To set the LASER voltage limit, use the SELECT push button in the PARAMETER section of the front panel to select COMP V and then press the (PARAMETER) SET push button to adjust the voltage limit using the adjust knob.

Now you are ready to enable the current source output for your laser diode.

In the MODE section of the front panel, press the push button labeled OUTPUT. The accompanying LED labeled ON will illuminate, indicating that the laser current source's output is enabled. The instrument will drive the current source to the value set by the corresponding MODE setpoint. When the LASER output is off, an internal short is placed across the LASER output. The OUTPUT switch has a toggling action. Pressing the switch again will disable the current source output and the ON LED will not be illuminated. The default condition for the current source output is off when the instrument is first powered up. With the laser output enabled, the LASER display should be indicating measured laser current. If the output won't function, check the following conditions:

Conditions That Will Automatically Shut Off the LASER OUTPUT

The following conditions will automatically cause the instrument to disable the current source output:

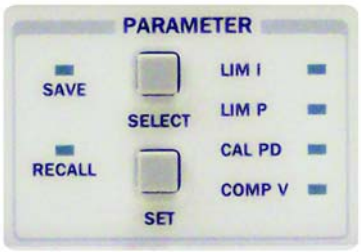
- LASER High Power Limit
- LASER Interlock / Key Lock Turned Off
- LASER Open Circuit or Voltage Limit

Operating a Laser in Constant Power (P) Mode

Suppose you want to operate a 3 mW laser at constant 1mW level. The LDX-3232 allows you to operate the laser current source driver in a Constant Power mode. In this mode, the LDX-3232 drives current to the laser to reach a setpoint power value (in mW). The control loop feedback parameter is photodiode current that the LDX-3232 converts to optical power via a user-defined photodiode responsivity number. If laser power changes due to internal or environmental conditions, the LDX-3232 will increase/decrease the current to the laser to maintain the power setpoint. The following paragraphs detail the instrument configuration in Constant Power Mode.

To set the LDX-3232 in Constant Power mode, select P in the MODE section of the front panel by toggling the SELECT push button. Repeatedly pressing the (MODE) SELECT switch cycles through the current (I), light power (P), or high bandwidth current (I_{HBW}) control modes. The LED indicator shows the selected mode.

Entering Photodiode Responsivity Values



The photodiode responsivity, CAL photodiode, is used to convert between photodiode current and optical power of the laser diode. To enter the CAL photodiode parameter, select CAL PD with the (PARAMETER) SELECT push button by toggling down past LIM P. The indicator becomes lit when CAL PD is selected and the display indicates the responsivity parameter in µA/mW (not an-nunciated). Rotate the adjust knob after pressing the (PARAMETER) SET push button to enter a new value for responsivity. After three seconds, the new parameter value is stored in non-volatile memory.

A method to calculate the responsivity is suggested below.

1. Measure (with a calibrated detector) the output power of the device.
2. Measure the corresponding photodiode current.
3. Calculate the responsivity by dividing the photodiode current by the optical power noting the units required are µA/mW.

The LDX-3232 High Compliance Current Source can be put into a special mode with the CAL PD parameter set to zero. When the CAL PD value is zero, the LASER output will be controlled to the I_{PD} setpoint value. Therefore, the instrument is in Constant I_{PD} mode. The display will indicate "-.-" for the power measurement.

Next, configure the display so that it reads in mW by pressing and releasing the (DISPLAY) SELECT switch until the mW annunciator is lit.

Adjust the Constant Power setpoint of the LDX-3232 to 1.00 mW. To do this, turn the adjust knob to vary the setpoint. When the adjust knob is turned, the LDX-3232 automatically changes to setpoint mode as indicated by the flashing annunciator. Adjust the setpoint to 1.00 mW. After an adjustment has been made, and the adjust knob is released, the setpoint mode will time out in three seconds. The display will then return to the measurement display mode (I, I_{PD}, V, or P_{PD}).

Before the laser output is enabled, the power limit for the laser under test should be set. In Constant Power mode, this is accomplished by setting a Power limit, LIM P value. The LDX-3232 uses the responsivity value entered to calculate a power limit as a function of monitor current (I_{PD}). This is a software limit only.

To set the Constant Power limit, use the SELECT push button in the PARAMETER section to select LIM P. When the LIM P is indicated by the accompanying LED, the display will indicate the limit setpoint in mW. Press the (PARAMETER) SET push button and rotate the adjust knob to set the limit to 1.50 mW. When the desired value is reached, the new limit value. will be stored in three seconds.

The LIM P is the absolute limit of optical power, as detected by the unit via the monitor photodiode feedback loop. In order for this limit to be meaningful, the monitor photodiode responsivity (CAL PD) must be adjusted correctly. This limit is a software limit only. The LASER output is normally turned off if this limit is reached (See LASer:ENABle:OUTOFF command in Chapter 4 for instructions on disabling this function). The maximum LIM P value is 5000.0 mW.

Also, in constant power mode the LASER current limit and voltage limit values are in effect. Setting of these limits is described later in this chapter.

Now the instrument is configured to operate in Constant Power Mode. In the MODE section, enable the output of the laser current source by depressing the OUTPUT push button once. The accompanying LED labeled ON will illuminate indicating that the laser output is on and current is being driven to the laser. The LDX-3232 current source will drive the laser to the Constant Power setpoint and maintain closed loop control with the photodiode current measurement.

Error Indicators

The LDX-3232 High Compliance Current Sources indicate general operational error conditions. Each error condition results in an action as shown in the table below.

Table 2.2 LDX-3232 Error Indicators

Error Condition	Action
Interlock	Output off; INTERLOCK light flashes at 1 Hz
Open Circuit	Output off; OPEN CIRCUIT light flashes at 1 Hz; if this condition was caused by an excessively high compliance voltage, the VOLTAGE LIMIT light will also be turned on.
Current Limit	CURRENT LIMIT light flashes at 1 Hz
Voltage Limit	VOLTAGE LIMIT light flashes at 1 Hz; this indicator warns that the output is within 0.25 V of LIM V setting; if the voltage limit (LIM V) is reached, the LASER output will shut off.
Optical Output Power Limit	Output off; POWER LIMIT light flashes at 1 Hz

CHAPTER 3

REMOTE OPERATION

Everything you learned to do from the front panel can also be done remotely and in some cases, with more flexibility. For instance, in remote mode, you have access to commands for functions not found on the front panel, such as commands that will increment (INC) and decrement (DEC) the current setpoint by a pre-defined step value. The following sections show you the fundamentals of operating your LDX-3232 High Compliance Current Source remotely through the GPIB interface.

Reading the GPIB Address

Before you can operate the LDX-3232 instrument from a remote location, you need to know its GPIB address. Simply press the LOCAL switch in the section labeled GPIB on the front panel. The instrument will display the address. The default address from the factory is address "Adr 01".

Changing the GPIB Address

Every device on the GPIB bus must have a unique address. If it is necessary to change the address, press and hold in the (PARAMETER) SET switch while displaying the GPIB address. Turn the ADJUST knob until the desired address value is displayed, then release the SET switch. The new GPIB address will then be stored in non-volatile memory. The allowable address range is 0-30 for primary GPIB addressing. Extended GPIB addressing is not implemented on the LDX-3232 at this time.

Changing Operation from Local to Remote

Sending a command over the GPIB will automatically put the instrument in REMOTE mode. The REMOTE indicator will identify when the Current Source is in remote operation mode. When the instrument is in REMOTE mode, pressing the LOCAL switch returns the instrument to LOCAL control mode unless a Local Lockout state has been activated by the low level GPIB command LLO from the host computer. Local Lockout disables all LDX-3232 High Compliance Current Source front panel switches until this condition is changed by the host computer. In this condition, the REMOTE indicator will flash at a 1Hz rate.

The TALK/LISTEN indicator is illuminated when the instrument is communicating over the GPIB bus.

For more information on low level interface commands such as LLO, refer to the IEEE488.1 specification.

LDX-3232 Current Source Command Set

For the most efficient and effective remote control of your LDX-3232 High Compliance Current Source, we recommend you study the following sections. You will learn about the LDX-3232 command sets, both GPIB-IEEE488 Command Commands and the most used device specific commands, and command syntax. Later in this chapter you will be introduced to the error and status registers.

Command Syntax

Any command or command query must contain all of the letters that are shown in the LDX-3232 Command Path Structure, Figure 3.2. However, the Current Source's command parser is NOT CASE SENSITIVE so upper or lower case may be used in any combination. The lower case letters shown with the Device Dependent commands in Chapter 4 are optional letters and may be used for clarity. For example, the following commands are equal:

- `LAS:DIS 1`
- `LAS:DisP 1`
- `LAS:DISPLAY 1`

In this example, only the first three letters "DIS" are required, while the other letters, "play" are optional. These optional letters must be used in the proper sequence as shown.

The syntax of the LDX-3232 High Compliance Current Source commands follows the rules laid out in the GPIB-IEEE488 standard. Colons (:) indicate the start of a new command path, while semicolons (;) indicate a separation of commands within a command string. A leading colon on a command may be used to return the LDX-3232 High Compliance Current Source command parser to the command path root (see Figure 3.1).

Spaces or white space may be used to separate commands and/or data (after the command header or query question mark). Spaces or white space must be used to separate the command (header) from the first parameter (or program data). The following examples show valid syntax for commands with the LDX-3232 High Compliance Current Source:

- `LAS:display:ldi`
- `Laser:limit:ldi 400`
- `LAS:DIS 1; las:set:ldi?`
- `Las:MODE:Mdp; LAS:OUT 1`

The following are examples of invalid syntax for the LDX-3232 High Compliance Current Source. These command strings would produce an erroneous result, as explained:

`LAS:MODE MDP`	Missing colon, MODE? expected
`LAS:MODE:ILBW DEC`	Missing semicolon, DEC command generates an error
`LAS:DIS ?`	Space not allowed before question mark, DIS command expected
`Las:LDI33;dis?`	Space missing between LDI command and the parameter value, 33

For further clarity in programming, the (Boolean) values of one (1) and zero (0) may be used or their names as indicated in the following table:

Table 3.1 Substitute Parameter Names

Substitute Name	Value
ON	1
OFF	0
OLD	1
NEW	0
TRUE	1
FALSE	0
SET	1
RESET	0

If multiple parameters are expected, they should be separated with commas:

```
LAS:INC 100,50
```

A query has no space between the mnemonic and the question mark:

```
LAS:LDI?
```

The LDX-3232 High Compliance Current Source uses a terminator of <NL><^END> (new line with EOI). For users whose GPIB driver defaults expect a carriage return in the terminator, <CR><NL><^END>, the TERM command may be used for convenience (see TERM command in Chapter 4). For more information, refer to your GPIB driver configuration manual.

The command structure is illustrated in Figure 3.1. Table 4.1 lists all of the LDX-3232 High Compliance Current Source's device-dependent commands, with the full path shown for each command and a brief explanation of its usage.

Command Paths

The LDX-3232 High Compliance Current Source device-dependent commands are structured into a tree format (see Figure 3.1). Each of the legal paths is listed below, followed by its list of path options, each of that is followed by the commands themselves. It is recommended that the first-time user begin learning the commands by using the full path notation. Once you are familiar with the commands, you may wish to take advantage of the shortcuts allowed for command paths.

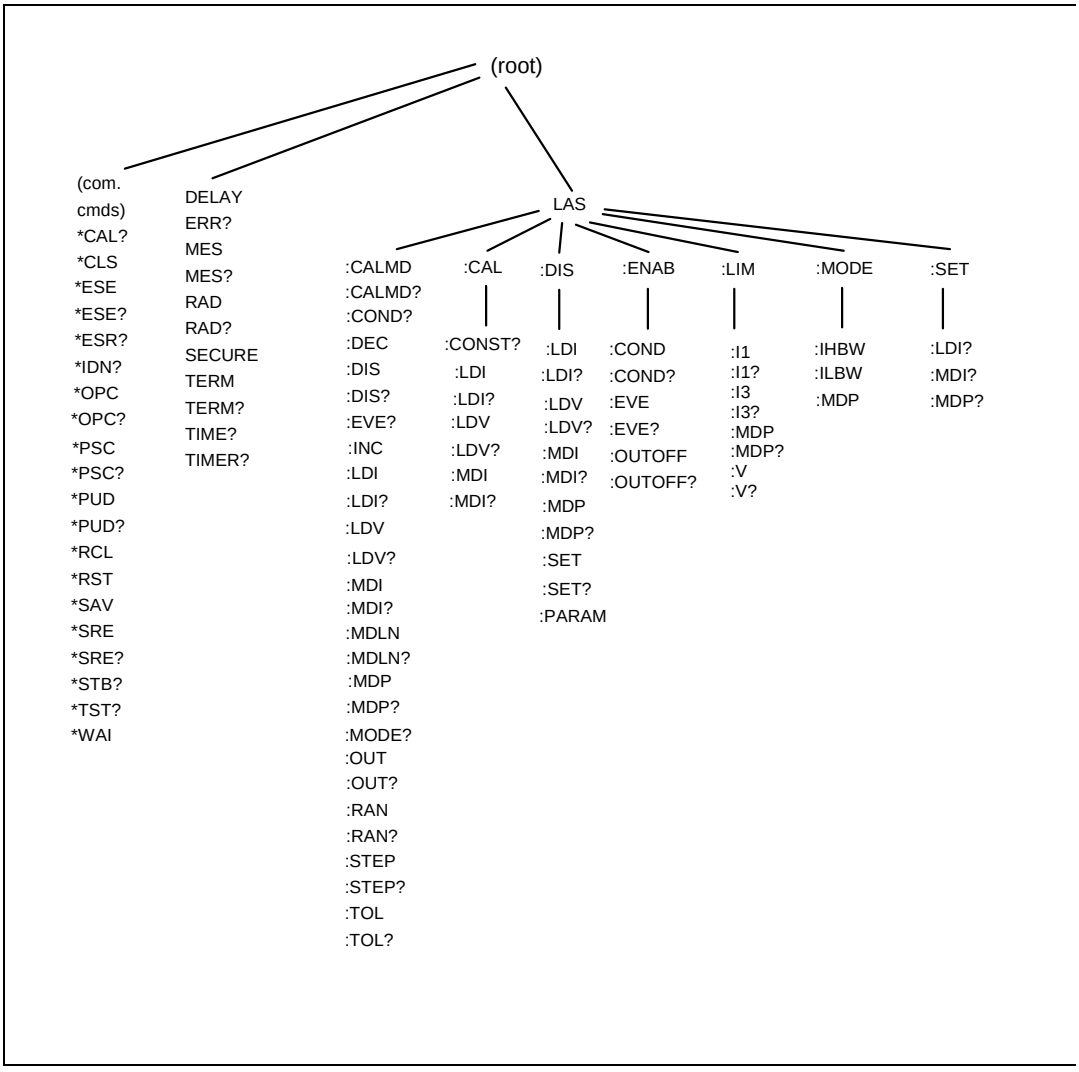
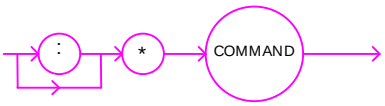


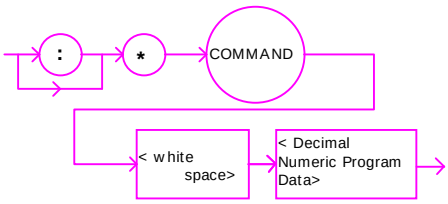
Figure 3.1 LDX-3232 Command Path Structure

IEEE488.2 Command Commands

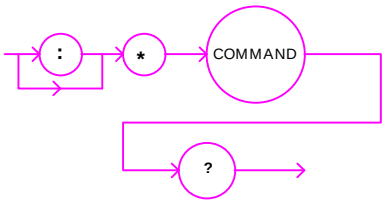
The IEEE488.2 Common Commands and Queries are distinguished by the "*" that begins each mnemonic. The diagrams below show the syntax structure for common commands, common commands with numeric data required, and command command queries.



Common Command



Common Command with Numeric Data



Common Command Query

Numeric data is required with *PSC (1=on, 0=off), *RCL (0 to 10, see front panel RECALL function), *SAV (1 to 10, see front panel SAVE function), *ESE (0 to 255, see Figure 3.2), *SRE (0 to 255, see Figure 3.2), and *PUD (used at factory only).

A list of all of the GPIB-IEEE488 Common Commands supported by the LDX-3232 follows:

*CAL?	*CLS	*ESE
*ESE?	*ESR?	*IDN?
*OPC	*OPC?	*PSC
*PSC?	*PUD	*PUD?
*RCL	*RST	*SAV
*SRE?	*SRE	*STB?
*TST?	*WAI	

For more information on these commands, refer to an ANSI/IEEE 488-1987 standards reference.

Note: Care should be taken to set the GPIB time-out appropriately for use with the *WAI, DELAY, or *OPC? Commands. If the time for a response after one of these commands exceed the GPIB time-out period, a bus (timeout) error will occur. Usually, after this timeout error, the LDX-3232 Series Instrument will generate a query error (E302). This error code is reported via the ERR? Query.

LDX-3232 Frequently Used Commands

The LDX-3232 High Compliance Current Source's complete command set contains over 60 commands that allow you to operate the current source for a variety of applications. Within the command set, however, is a smaller subset of commands that will meet most of your needs. These commands are listed in Table 3.2.

Table 3.2 LDX-3232 Often Used Commands

Name	Parameters	Function
ERR?	NONE	Returns errors generated since the last query
LAS:CALMD	1	Used to set the CAL PD (monitor responsivity) constant
LAS:LDI	1	Used to set the current source setpoint value
LAS:LDI?	NONE	Used to return the constant current source measured value
LAS:LDV?	NONE	Used to return the measured laser voltage value
LAS:LIM:I2	1	Used to set the low range current limit
LAS:LIM:I4	1	Used to set the high range current limit
LAS:LIM:MDP	1	Used to set the constant optical power (from monitor photodiode) limit value
LAS:LIM:V	1	Used to set the current source compliance voltage limit value (LIM V)
LAS:MDP	1	Used to set the constant optical power setpoint
LAS:MDP?	NONE	Returns the actual monitor photodiode power value
LAS:MODE?	NONE	Returns the mode, ILBW, IHBW, or MDP (optical power)
LAS:MODE:IHBW	NONE	Sets the mode to constant current, high bandwidth mode
LAS:MODE:ILBW	NONE	Sets the mode to constant current, low bandwidth mode
LAS:MODE:MDP	NONE	Sets the mode to constant optical power mode
LAS:OUT	1	Used to enable/disable the current source output
LAS:OUT?	NONE	Returns the current source output status
LAS:RAN	1	Sets the laser current output range

Status Reporting

This section contains information that is relevant for understanding instrument error and statu reporting. It also contains information regarding the use of the instrument status for generating interrupts for interrupt driven programs or subroutines. Understanding the Operation Complete definition for the instrument is useful for programming synchronization. The Output Off Register section also contains iformation on setting some of the conditions that will force the laser current source output off.

The following sections describe the Event and Condition registers, Operation Complete Flag, Output Off registers, and Error Messages.

Event and Condition Registers

In addition to the required GPIB-IEEE488 status reporting structures, the LDX-3232 High Compliance Current Source remote interface provides Event and Condition Registers for LASER operations. The Event Registers are used to report events that occur during the operation of the LDX-3232 High Compliance Current Source. Events differ from conditions in that events signal an occurrence once, and are not reset until the Event Register is queried, the status cleared by the `*CLS` command, or the instrument is powered off. Conditions reflect the current state of the device and therefore may change many times during operation. Querying a Condition Register does not change its contents.

Figure 3.3 shows the status reporting scheme of the LDX-3232 High Compliance Current Source. Each of the registers that may be accessed by a command or query has the appropriate command or query written above or below the register representation. For example, the LASER Condition Register may be queried via the `LASer:COND?` query.

The condition or event registers are logically ANDed with their respective enable registers. These bits are then logically ORed to form a summary message in the status byte for that particular register.

Operation Complete Definition

Note that Bit 0 of the Standard Event Status Register contains the status of the Operation Complete flag. Enabling this bit via the `*ESE` command allows the user to update bit 5 of the status byte. Then, if the SRE mask has bit 5 set, and the user issues an `*OPC` command, the SRQ (bus) signal will be generated upon completion of the currently processed commands. This bus signal (SRQ) may be used to initiate service request routines, that depend on the completion of all previous commands.

For example, the user may turn the current source on (`LAS:OUT 1`), enable an SRQ on Operation Complete (set `*ESE 1` and `*SRE 5`), and have an SRQ handling routine in the user's software, that reads a new measurement after the output on state has been reached. This allows the use of the operation complete features of the LDX-3232, without the need for program looping or polling that can tie up the GPIB. Operation Complete on the LDX-3232 is defined as:

1. No operations to the LASER current source hardware are pending.
2. No EEPROM (non-volatile) memory write cycles are in progress.

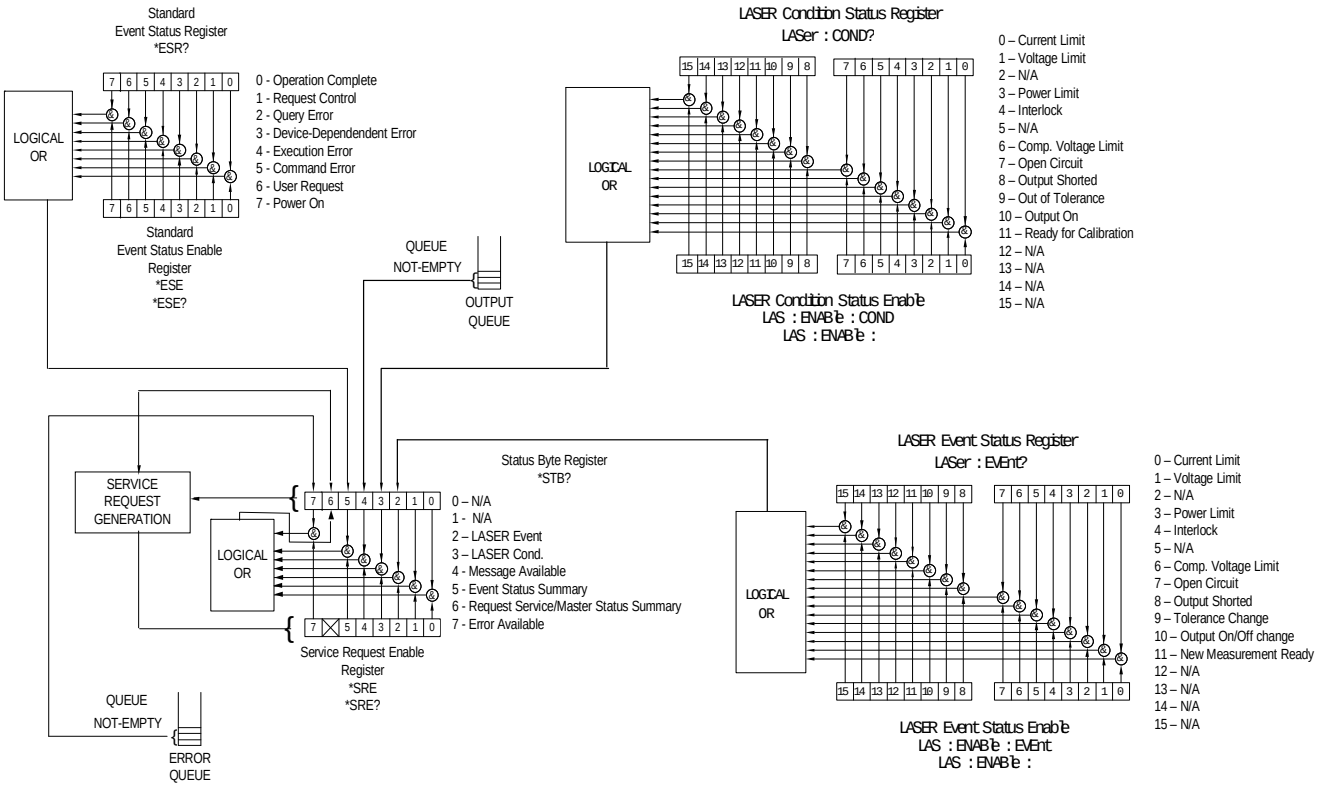


Figure 3.2 LDX-3232 Status Reporting Schematic Diagram

Note: If the GPIB times out while waiting for a response, either set the GPIB time-our longer or use SRQ generated interrupts in your program. See your GPIB manual for time-out configuration or SRQ programming setup.

The `*OPC`, `*OPC?` and `*WAI` commands should not be used inside a calibration routine.

Output Off Register

The Output Off Enable Register allows you to determine that conditions and events in the LDX-3232 High Compliance Current Source can cause the current source output to be turned off. This reigster is configured in a manner similar to the status reporting registers. However, the register output is not reported in the Status Byte Register. Rather, it sets the hardware that controls the output switching. The events and conditions that may be set to cause the current source output to be turned off are shown in Figure 3.3.

The default (factory) settings for this register are shown in Table 3.3. These settings are not affected by the *PSC (Power-On Status Clear) command.

Table 3.3 LDX-3232 Series Default Settings for Output Off Registers

0 - disabled	8 - N/A
1 - disabled	9 - disabled
2 - N/A	10 - N/A
3 - enabled	11 - N/A
4 - N/A	12 - N/A
5 - N/A	13 - N/A
6 - N/A	14 - N/A
7 - N/A	15 - N/A

r

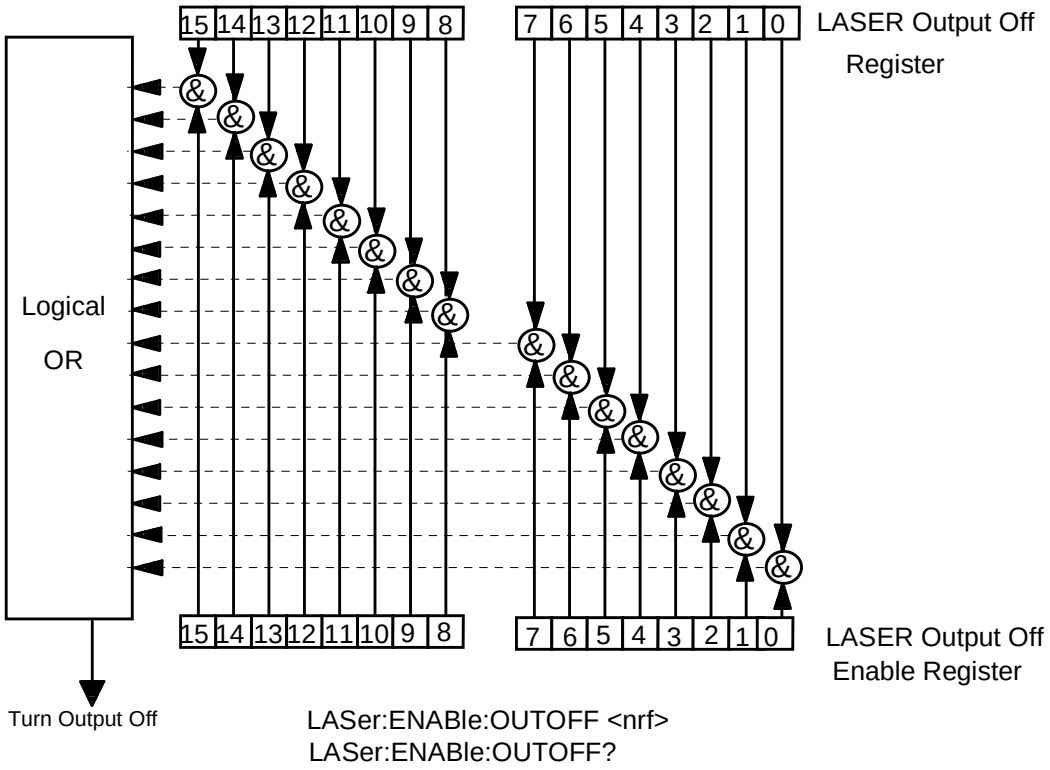

15 14 13 12 11 10 9 8
7 6 5 4 3 2 1 0
LASER Output Off Register
Logical OR
15 14 13 12 11 10 9 8
7 6 5 4 3 2 1 0
LASER Output Off Enable Register
Turn Output Off
LASer:ENABle:OUTOFF <nrf>
LASer:ENABle:OUTOFF?

Figure 3.3 LDX-3232 Output Off Register

0 - LASER Current Limit	8 - N/A
1 - LASER Voltage Limit	9 - LASER Output Changed to be Out of Tolerance
2 - N/A	10 - N/A
3 - LASER Power Limit (output on)	11 - N/A
4 - N/A	12 - N/A
5 - N/A	13 - N/A
6 - N/A	14 - N/A
7 - N/A	15 - N/A

Command Timing and Completion

This section describes, for each device-dependent command, whether that command is performed in an overlapped or sequential manner. In other words, it states whether the next command may begin while the current command is being executed, or if the next command must wait until the current command is completed before its execution begins. The conditions for setting the operation complete flag are given in the Chapter 3 section titled Operation Complete Definition.

All LDX-3232 device-dependent commands are executed in an overlapped manner, except the DELAY command that is sequential. The operation complete flag is set after the conditions outlined in the Operation Complete Definition have been satisfied.

The *WAI (common command) is an example of a sequential command that forces the next command to wait until the no-operation-pending flag is true. This is essentially the same as waiting for the OPC flag to become true, because the no-operations-pending flag is used to set the OPC flag (bit 0 of the Standard Event Status Register).

Commands that change the status of the instrument limits or change its mode or current range, step value, or status enable registers will not have their OPC flag set until all current writing to non-volatile memory has been completed. This is done to ensure that the OPC flag is never set prematurely.

Whenever there is any output (response) data in the Output Queue, bit 4 is set in the Status Byte Register. Whenever there is any error message in the Error Queue, bit 7 is set in the Status Byte Register.

Error Messages

In the event of a hardware error condition, error messages will be displayed on the display. In most cases, the error message will appear for three seconds. In some cases the error code display will remain until the user changes display modes. In the case of multiple error messages, the display may sequentially show each message for three seconds. In addition to the hardware errors, GPIB errors may be read via the ERR? query. Table 3.4 lists the numerical error ranges by function. Table 3.5 contains all of the error messages that may be generated. Not all of these messages may appear on the front panel displays. Some refer to GPIB activities only.

In remote operation, the errors can be read by issuing the ERR? query. When this is done, all of the error messages that are resident in the error queue are returned

(up to 10 may be stored). Reading the error queue via GPIB clears the error queue.

Table 3.4 Error Code Classifications

Error Code Range	Area of Operation
E-001 to E-099	Internal Program Errors
E-100 to E-199	Parser Errors
E-200 to E-299	Execution Control Errors
E-300 to E-399	GPIB Errors
E-500 to E-599	LASER Control Errors

Table 3.5 LDX-3232 Series Error Codes

Error Code	Explanation
E-001	Memory allocation failure
E-103	<DEFINITE LENGTH ARBITRARY BLOCK PROGRAM DATA> length too long
E-104	<NON-DECIMAL NUMERIC PROGRAM DATA> type not defined
E-105	<DECIMAL PROGRAM DATA> exponent not valid
E-106	<DECIMAL PROGRAM DATA> digit expected
E-123	Command not found
E-124	<program mnemonic> Lookup, failed because query/command type match failed
E-126	Too few or too many program data elements
E-201	<PROGRAM DATA> value out of range
E-202	<PROGRAM DATA> will not convert to valid type
E-203	Security violation, command is not available without clearance
E-205	<PROGRAM DATA> is not a Boolean value or word
E-207	<PROGRAM DATA> will not convert to an unsigned 16-bit value
E-209	<PROGRAM DATA> will not convert to an unsigned 32-bit value
E-210	<PROGRAM DATA> will not convert to a floating point value
E-211	<PROGRAM DATA> will not convert to a character value
E-213	<PROGRAM DATA> is incorrect block data length
E-214	<PROGRAM DATA> length exceeds maximum
E-302	Query error; device was addressed to talk, but GPIB controller failed to read all of the <RESPONSE MESSAGE>

Error Code	Explanation
E-501	LASER interlock disabled output
E-503	LASER open circuit disabled output
E-504	LASER current limit disabled output
E-505	LASER voltage limit disabled output
E-507	LASER power limit disabled output
E-510	LASER out of tolerance disabled output
E-511	LASER control error disabled output
E-512	Analog section status is all 1's or all 0's (power down)
E-513	Serial EEPROM checksum error
E-515	Laser output must be off to change ranges
E-516	Incorrect configuration for calibration sequence to start
E-519	Setting a measurement is only valid during the calibration phase for that measurement; user has tried to calibrate a measurement without first entering the required calibration mode.

CHAPTER 4

COMMAND REFERENCE

This chapter is a guide to all of the device-dependent commands for the LDX-3232 High Compliance Current Source. This chapter is divided into two parts. The first part contains an overview of the remote commands used by the LDX-3232 High Compliance Current Source. The second part contains all of the LDX-3232 commands in alphabetical order. Figure 4.1 shows the format for the device command descriptions in this chapter. The commands that emulate local (front panel) operation are denoted by the solid box next to the Local label in the upper left corner of the command description.

Table 4.1 LDX-3232 Series Device-Dependent Commands

Name	Parameters	Function
DELAY	1	Used to create a delay in the execution of further commands
ERR?	NONE	Returns errors generated since the last query
LAS:CALMD	1	Used to set the CAL PD (monitor responsivity) constant
LAS:CALMD?	NONE	Returns the CAL PD (monitor responsivity) constant
LAS:CAL:CONST?	1	Factory use only
LAS:CAL:LDI	NONE	Used to enter the laser current calibration mode
LAS:CAL:LDI?	NONE	Returns the ready state for entering the laser current calibration value
LAS:CAL:LDV	NONE	Used to enter the laser voltage calibration mode
LAS:CAL:LDV?	NONE	Returns the ready state for entering the laser voltage calibration mode
LAS:CAL:MDI	NONE	Used to enter the monitor photodiode current calibration mode

Name	Parameters	Function
LAS:CAL:MDI?	NONE	Returns the ready state for entering the monitor photodiode current calibration value
LAS:COND?	NONE	Returns the value of the LASER condition register
LAS:DEC	0	Used to decrease the laser current setpoint value by one step
LAS:DIS	1	Turns the LASER display on or off
LAS:DIS?	NONE	Returns the LASER display value
LAS:DIS:LDI	NONE	Turn on/off LASER display to show laser output current
LAS:DIS:LDI?	NONE	Returns status of laser output current display, on/off
LAS:DIS:LDV	NONE	Turn on/off LASER display to show laser output voltage
LAS:DIS:LDV?	NONE	Returns status of laser output voltage display, on/off
LAS:DIS:MDI	NONE	Turn on/off LASER display to show photodiode monitor current
LAS:DIS:MDI?	NONE	Returns status of photo diode monitor current display, on/off
LAS:DIS:MDP	NONE	Turns on/off LASER display to show photodiode monitor power
LAS:DIS:MDP?	NONE	Returns status of photodiode monitor power display, on/off
LAS:DIS:PARAM	NONE	Enables LASER display to show parameter values
LAS:DIS:SET	NONE	Shows the LASER display setpoint corresponding to mode
LAS:DIS:SET?	NONE	Returns status of LASER setpoint display, on/off
LAS:ENAB:COND	1	Sets the enable register for LASER conditions
LAS:ENAB:COND?	NONE	Returns the value of the LAS conditions enable register
LAS:ENAB:EVE	1	Sets the enable register for LAS events
LAS:ENAB:EVE?	NONE	Returns the value of the LAS event enable register
LAS:ENAB:OUTOFF	1	Sets the enable register for LAS conditions, that turn the LAS output off
LAS:ENAB:OUTOFF?	NONE	Returns the value of the LAS outoff enable register
LAS:EVENT?	NONE	Returns the value of the LAS event register
LAS:LDI	1	Used to set the LASER constant current source setpoint value
LAS:LDI?	NONE	Used to return the constant current source measured value
LAS:INC	0, 1, or 2	Used to increment the LASER setpoint value by one or more steps
LAS:LDV	1	Used to set the laser voltage value for calibration
LAS:LDV?	NONE	Used to return the measured laser voltage value

Name	Parameters	Function
LAS:LIM:I2	1	Used to set the LASER low range current source limit
LAS:LIM:I2?	NONE	Used to return the LASER low range current source limit
LAS:LIM:I4	1	Used to set the LASER high range current source limit
LAS:LIM:I4?	NONE	Used to return the LASER high range current source limit
LAS:LIM:MDP	1	Used to set the constant optical power (from monitor photodiode) limit value
LAS:LIM:MDP?	NONE	Used to return the optical power (from monitor photodiode) limit value
LAS:LIM:V	1	Used to set the LASER compliance voltage limit value
LAS:LIM:V?	NONE	Used to return the LASER compliance voltage limit value
LAS:MDI	1	Used to set the constant optical power setpoint, if photodiode responsivity is 0
LAS:MDI?	NONE	Used to return the monitor photodiode current measured value
LAS:MDLN	1	Used to enable/disable the front panel modulation input
LAS:MDLN?	NONE	Used to return the status of the front panel modulation input
LAS:MDP	1	Used to set the constant optical power setpoint
LAS:MDP?	NONE	Returns the actual monitor photodiode power value
LAS:MODE?	NONE	Returns the mode, I (current), IHBW (high bandwidth), or P (optical power)
LAS:MODE:IHBW	NONE	Sets the mode to constant current, high bandwidth
LAS:MODE:ILBW	NONE	Sets the mode to constant current, low bandwidth
LAS:MODE:MDP	NONE	Sets the mode to constant optical power mode
LAS:OUT	1	Used to enable/disable the current source output
LAS:OUT?	NONE	Returns the current source output status
LAS:RAN	1	Sets the laser current output range
LAS:RAN?	NONE	Returns the laser current output range
LAS:SET:LDI?	NONE	Returns the laser constant I (current) setpoint
LAS:SET:MDI?	NONE	Returns the laser constant optical power setpoint
LAS:SET:MDP?	NONE	Returns the constant P (optical power) setpoint
LAS:STEP	1	Used to set the LASER setpoint step value
LAS:STEP?	NONE	Returns the LASER setpoint step value
LAS:TOL	2	Used to set the LASER setpoint tolerance value and time period value

Name	Parameters	Function
LAS:TOL?	NONE	Used to return the LASER setpoint tolerance value and time period value
MES	1	Used to enter a string message of up to 16 bits
MES?	NONE	Returns a previously stored ASCII message
RAD	1	Sets the radix type for numerical data; decimal, binary, octal or hexadecimal
RAD?	NONE	Used to return the radix type for numerical data
TERM	1	Used to add a carriage return to the device terminator
TERM?	NONE	Returns the status of the TERM command
TIME?	NONE	Returns the elapsed time since the instrument was last powered up
TIMER?	NONE	Returns the elapsed time since the timer was last reset

LDX-3232 Device-Dependent Commands

This section contains all of the device-dependent commands for the LDX-3232 High Compliance Current Source, listed in alphabetical order. Sub-sections for each path are presented, listing the commands that are legal for that path. See Figure 3.1 for command path tree structure.

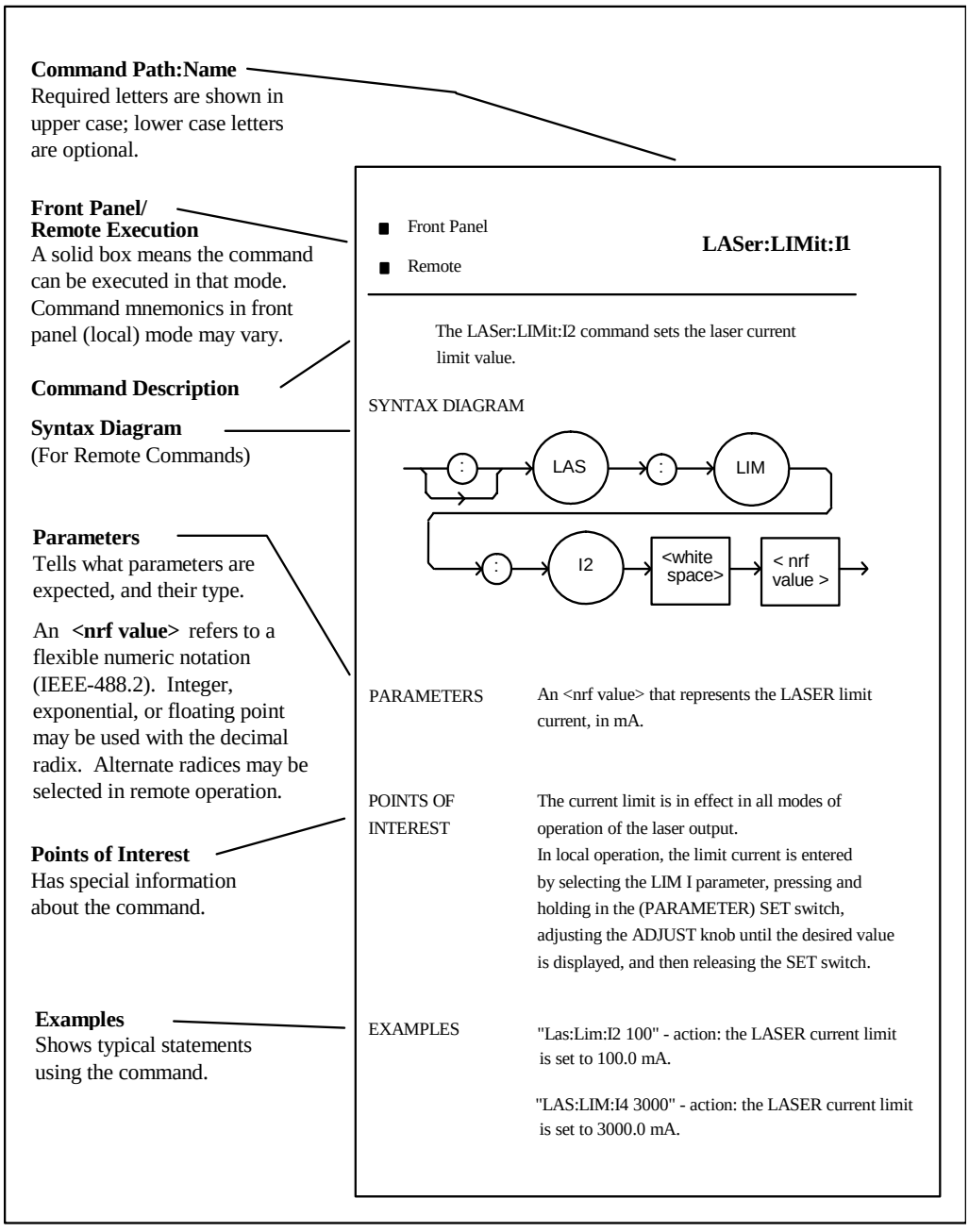

Command Path:Name
Required letters are shown in upper case; lower case letters are optional.
Front Panel/ Remote Execution
A solid box means the command can be executed in that mode. Command mnemonics in front panel (local) mode may vary.
Command Description
Syntax Diagram
(For Remote Commands)
Parameters
Tells what parameters are expected, and their type.
An <nrf value> refers to a flexible numeric notation (IEEE-488.2). Integer, exponential, or floating point may be used with the decimal radix. Alternate radices may be selected in remote operation.
Points of Interest
Has special information about the command.
Examples
Shows typical statements using the command.
Front Panel
Remote
LASer:LIMit:I1
The LASer:LIMit:I2 command sets the laser current limit value.
SYNTAX DIAGRAM
:
LAS
:
LIM
:
I2
<white space>
< nrf value >
PARAMETERS
An <nrf value> that represents the LASER limit current, in mA.
POINTS OF INTEREST
The current limit is in effect in all modes of operation of the laser output.
In local operation, the limit current is entered by selecting the LIM I parameter, pressing and holding in the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value is displayed, and then releasing the SET switch.
EXAMPLES
"Las:Lim:I2 100" - action: the LASER current limit is set to 100.0 mA.
"LAS:LIM:I4 3000" - action: the LASER current limit is set to 3000.0 mA.

Figure 4.1 Command Description Format

LDX-3232 Device-Dependent Command Reference

The following pages contain a reference for the device-dependent commands of the LDX-3232 High Compliance Current Source. This reference contains useful information for both local and remote operation of the LDX-3232.

References to the front panel labels are capitalized in the following reference pages (as is done throughout this manual). Therefore, a reference to the LOCAL switch is meant to signify the actual switch labeled LOCAL on the front panel of the LDX-3232.

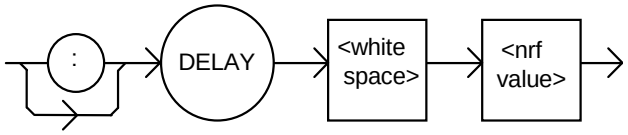
In some reference, parentheses are used to signify the labeled are for a particular switch or LED indicator on the front panel. For example, (PARAMETER) SET refers to the switch labeled “SET” in the PARAMETER area of the front panel.

DELAY

FRONT PANEL
REMOTE

The DELAY command causes the execution of commands to be delayed by a user-defined time. This command is similar to the *WAI common command, except that execution resumes after the specified number of miliseconds, instead of waiting for the Operation-Complete flag to be set.

Syntax Diagram



Parameters	An <nrf value> that represents the delay time in milliseconds.
Notes	The Operation-Complete flag is held false until the delay period elapses, but the *OPC? query will not execute until the delay period has elapsed.
	This command is useful for creating delays that don't require a lot of program code and don't tie up the GPIB during execution.
	The delay time is approximate, with an error of about ±10%.
Examples	"DELAY 500" -action: Further commands and queries are not executed until about 0.5 seconds have elapsed from the time this command is executed.
	“LAS:LDI 22;Delay 2000;LAS:LDI?” -actions: The current is set to 22.0 mA, then the LDX-3232 High Compliance Current Source waits for about 2.0 seconds before returning the measured current.

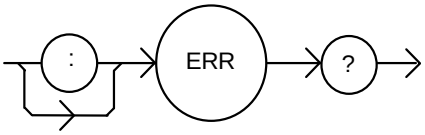
Note: Care should be taken to set the GPIB time-out appropriately for use with the Delay command.

ERRors?

FRONT PANEL
REMOTE

The ERRors? query returns a list of command and device errors that have occurred since the last query. These errors are notated by a number that corresponds to the type of error that occurred. See Chapter 3 for information regarding error handling.

Syntax Diagram



Parameters None.

Notes The response data will be a list of the current errors. The errors are represented by numbers and are separated by commas. A response of 0 indicates that no errors were reported. The response data is sent as character data. Up to 10 error codes are stored between error queries.

Examples "ERR?" -response: 0, means no errors reported.

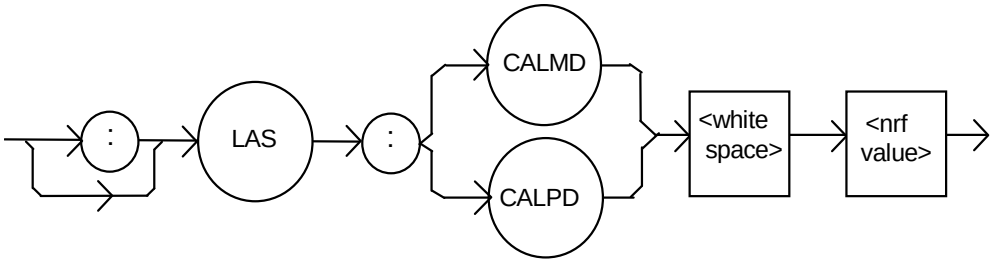
"Errors?" -response: 201, means that the <PROGRAM DATA> (parameter) value out of range error was reported since the last ERR? query.

LASer:CALMD

FRONT PANEL
REMOTE

The LASer:CALMD command sets the laser's photodiode feedback responsivity (the CAL PD parameter).

Syntax Diagram



Parameters An <nrf value>, in mA/mW. The range is 0 to 1000.

Notes If the parameter is set to 0, the LDX-3232 will operate in a constant I_{PD} mode, when Constant P (MDP) mode is selected.

The parameter should be set to 0 for I_{PD} operation modes. Otherwise, the value of this parameter is used to convert between I_{PD} and P_{PD} values. The units of this parameter are mA/mW.

Examples "LAS:CALMD 0" -action: sets the CAL PD parameter to 0. This enables the constant I_{PD} mode of operation.

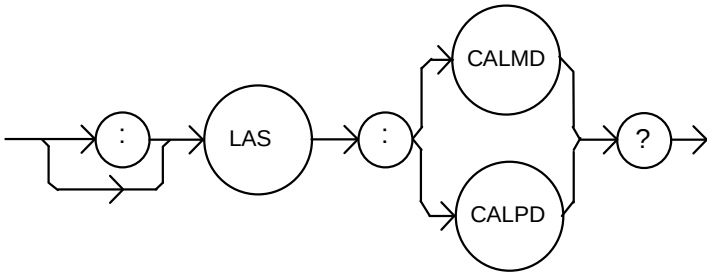
"Laser:Calmd 1" -action: sets the CAL PD parameter to 1.00 mA/mW. Therefore, a photodiode feedback current of 1 mA will cause the P_{PD} display to read 1 mW.

LASer:CALMD?

FRONT PANEL
REMOTE

The LASer:CALMD? query returns the value of the laser's photodiode feedback responsivity (CAL PD parameter) setting.

Syntax Diagram



Notes
If this value is 0, the LDX-3232 will be set to operate in constant I_{PD} mode, and the I_{PD} setpoint value will be in effect. If this value is non-zero, the LDX-3232 will be set to operate in constant P_{PD} mode, and the P_{PD} setpoint value will be in effect.
If this value is 0, the front panel P_{PD} will display "-.-" and no P_{PD} value can be calculated.

Examples
"LASER:CALMD?" -response: 0, means the LDX-3232 is set for operation in constant I_{PD} mode (if P mode is also selected).
"Las:Calmd?" -response: 1.1, means the LDX-3232 is set for operation in constant P_{PD} mode (if P mode is also selected) and the responsivity is set to 1.1 µA/mW. 1.1 µA of photodiode feedback current represents 1 mW of optical power.

LAS:CAL:CONST?

FRONT PANEL
REMOTE

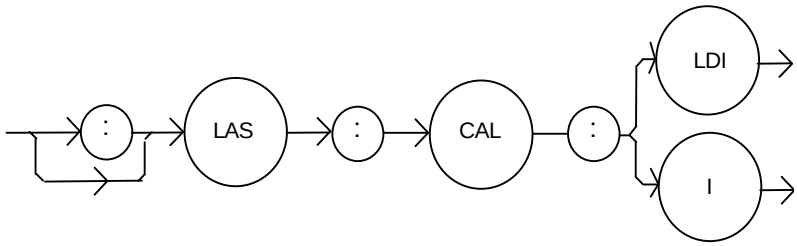
The LAS:CAL:CONST? query returns a stored calibration value. It is intended for factory use only.

LASer:CAL:LDI

FRONT PANEL
REMOTE

The LASer:CAL:LDI command is used to enter the LASER current setpoint, measurement, and limit (in low bandwidth mode) calibration mode.

Syntax Diagram



Parameters None

Notes Since the limit circuit is the same for both high and low bandwidth modes, it is only calibrated when low bandwidth mode is selected.

After this command is issued, the LDX-3232 High Compliance Current Source will allow calibration of the current setpoint, measurement, and limit (if low bandwidth mode is selected). This procedure is outlined in Chapter 6.

The calibration defaults to the selected bandwidth setting. Therefore, it is necessary to select the desired bandwidth (I or I_{HBW}) and turn the LASER output on before performing the calibration for that bandwidth.

Calibration is performed at the current setpoint, wherever it is set. If the LASER output is not on, E516 is displayed.

In remote operation, the LASer:CAL:LDI? query may be used to determine if the LDX-3232 High Compliance Current Source is ready for the user to enter a value.

Examples "Las:CAL:Ldl" -action: the LDX-3232 enters calibration mode for LASER current.

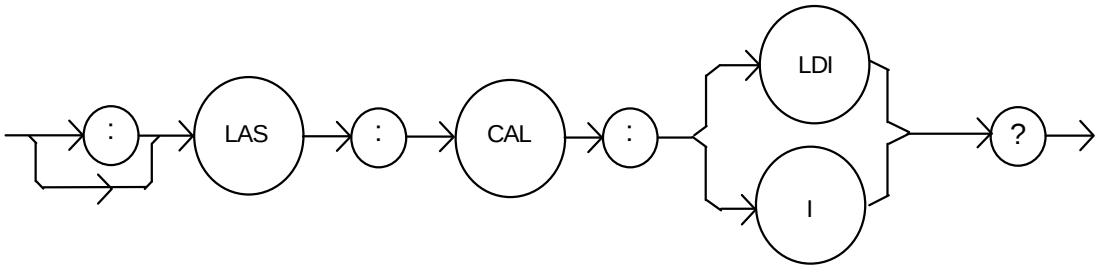
"Las:Cal:LDI" -action: the LDX-3232 enters calibration mode for LASER current.

LASer:CAL:LDI?

FRONT PANEL
REMOTE

The LASer:CAL:LDI? query is used to determine that the LDX-3232 is ready for a value to be entered during the calibration cycle of the LASer:CAL:LDI mode.

Syntax Diagram



Notes — After this query is issued and a response of 1 is received, the LDX-3232 will be ready for the user to enter a current value via the LASer:LDI command (see Chapter 6).

Examples — "LASer:CAL:LDI?" -response: 1, means the LDX-3232 is ready for the user to enter a current value via the LASer:LDI command.

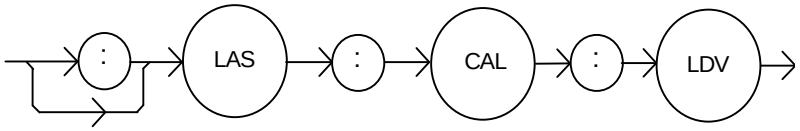
“LASer:Cal:LdI?” -response: 0, means the LDX-3232 is not yet ready for the user to enter a LASER current value

LASer:CAL:LDV

FRONT PANEL
REMOTE

The LASer:CAL:LDV command is used to enter the LASER voltage measurement calibration mode.

Syntax Diagram



Parameters — None

Notes — After this command is issued, the LDX-3232 will allow calibration of the laser voltage measurement. This procedure is outlined in Chapter 6.

The LASer:CAL:LDV? query may be used to determine if the LDX-3232 is ready for the user to enter a value.

Examples — "Las:CAL:Ldv" -action: the LDX-3232 enters calibration mode for LASER voltage.

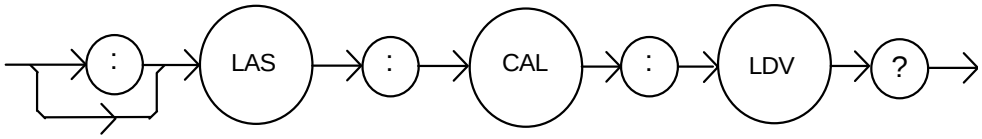
"Las:Cal:LDV" -action: the LDX-3232 enters calibration mode for LASER voltage.

LASer:CAL:LDV?

FRONT PANEL
REMOTE

The LASer:CAL:LDV? query is used to determine that the LDX-3232 is ready for a value to be entered during the calibration cycle of the LASer:CAL:LDV mode.

Syntax Diagram



Notes — After this query is issued and a response of 1 is received, the LDX-3232 will be ready for the user to enter a voltage value via the LASer:LDV command (see Chapter 6).

Examples — "LASer:CAL:LDV?" -response: 1, means the LDX-3232 is ready for the user to enter a voltage value via the LASer:LDV command.

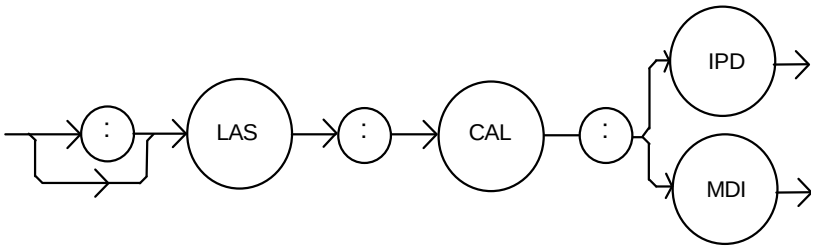
"LASer:Cal:LdV?" -response: 0, means the LDX-3232 is not yet ready for the user to enter a LASER voltage value.

LASer:CAL:MDI

FRONT PANEL
REMOTE

The LASer:CAL:MDI command is used to enter the LASER photodiode current calibration mode.

Syntax Diagram



Parameters — None

Notes — After this command is issued, the LDX-3232 will automatically enter the LASER photodiode current calibration mode. When the LDX-3232 is ready, the user should enter the true measured value. This procedure is outlined in Chapter 6.

If the LASER output is not ON or if the P mode is not selected, error code E-516 will be generated.

In remote operation, the LASer:CAL:MDI? query may be used to determine if the LDX-3232 is ready for the user to enter a value via the LASer:MDI command.

Examples — "Las:CAL:MDI" -action: the LDX-3232 enters the LASER photodiode current calibration mode.

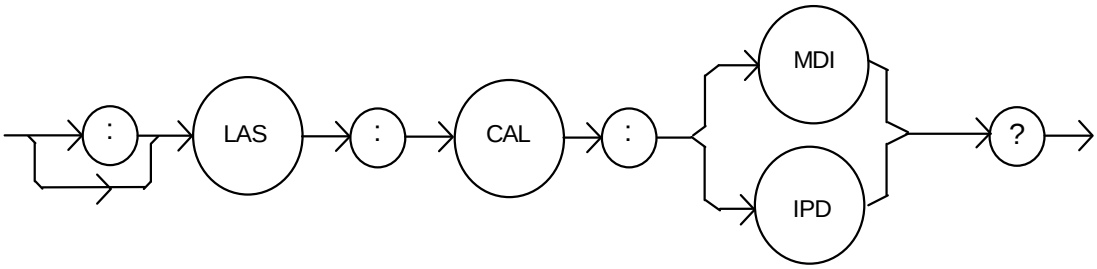
"LAS:Cal:MDI" -action: the LDX-3232 enters the LASER photodiode current calibration mode.

LASer:CAL:MDI?

FRONT PANEL
REMOTE

The LASer:CAL:MDI? query is used to determine that the LDX-3232 is ready for a value to be entered during the calibration cycle of the LASer:CAL:MDI mode.

Syntax Diagram



Notes — After this query is issued and a response of 1 is received, the LDX-3232 be ready for the user to enter a photodiode current value via the LASer:MDI command (see Chapter 6).

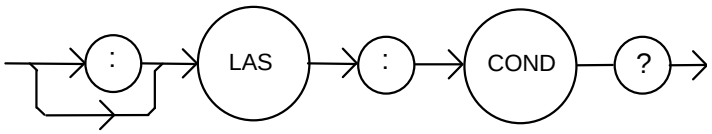
Examples — "LAS:CAL:MDI?" -response: 1, means the LDX-3232 is ready for the user to enter a photodiode current value via the LASer:MDI command.

LASer:COND?

FRONT PANEL
REMOTE

The LASer:COND? query returns the value of the status condition register of the LASER operations.

Syntax Diagram



-where the response is the sum of the following:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output is outside tolerance limit
4	N/A	1024	Output on/off state
8	Power limit	2048	Ready for calibration data state
16	Interlock disabled	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes — The LASER conditions that are reported to the status byte are set via the LASer:ENABle:COND command.

The Open circuit condition is only present while the LASER output is on, and when the hardware detects this condition, it will turn the LASER output off. Therefore, the Open

Circuit condition is fleeting and may be missed via the LAS:COND? query. Therefore, the user should test for the Open Circuit Event via the LAS:EVEnt? query.

The LASER condition status is constantly changing, while the event status is only cleared when the event status is read or the *CLS command is issued.

Examples "LAS:COND?" -response: 513, means that the LASER limit current and out of tolerance LASER conditions currently exist.

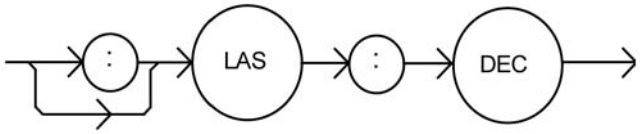
"Radix Hex; Laser:Cond?" -response: #H108, means that the LASER Output shorted and Power limit conditions currently exist.

LASer:DEC

FRONT PANEL
REMOTE

The LASer:DEC command decrements the selected laser control mode setpoint by one step. This is an overlapped command. Other commands may be executed while this function is in progress.

Syntax Diagram



Parameters None.

Notes The decremental default amount is one step. The step size can be edited via the LAS:STEP command. LDX-3232 default values are 0.1 mA, 0.1 mW, or 1 µA (if CALMD = 0).

The minimum time to complete one decrement is about 20 ms.

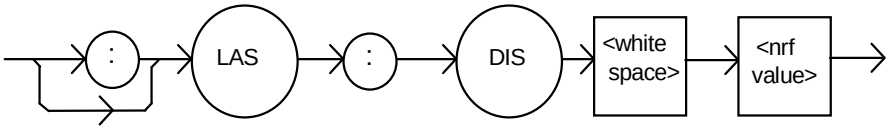
Examples "LAS:MODE:I; LAS:STEP 3; LAS:DEC" -action: The laser source current setpoint is decremented by 0.3 mA.

LASer:DISplay

FRONT PANEL
REMOTE

The LASer:DISplay command enables or disables (turns off) the display and some LEDs

Syntax Diagram



Parameters An <nrf value>; -where 1 = on, 0 = off.

Notes Turning the display and LEDs off means that a message of all blank spaces is sent to the display, and most of the LEDs will be turned off.

Examples "las:dis 1" -action: turns the LASER display on and enables the LASER indicator LEDs.

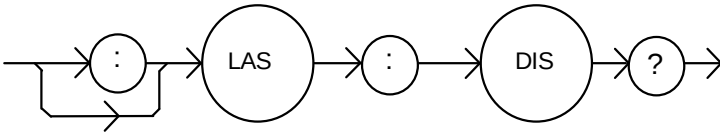
"Laser:dis Off" -action: turns the LASER display and disables the LASER indicator LEDs.

LASer:DISplay?

FRONT PANEL
REMOTE

The LASer:DISplay? query returns the value shown on the display.

Syntax Diagram



Notes — Returns the actual (6-character) string from the output buffer to the display. If the display is disabled, it returns " .".

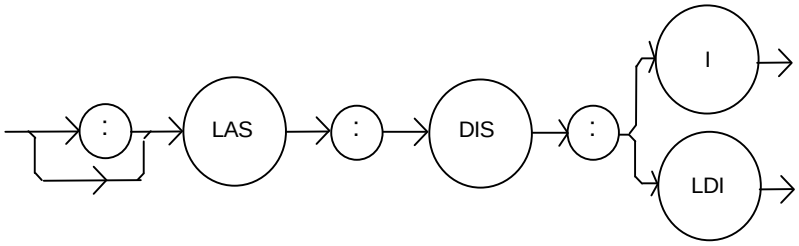
Examples — "LAS:DIS?" -response: "- 99.9", means the LASER display shows "- 99.9".
"Laser:DISp?" -response: " 0.6", means the LASER display shows " 0.6".

LASer:DISplay:LDI

FRONT PANEL
REMOTE

The LASer:DISplay:LDI command sets the laser display to show the constant current measurement.

Syntax Diagram



Parameters — None.

Notes — The LDI measurement display mode is turned off automatically when another display selection is enabled.

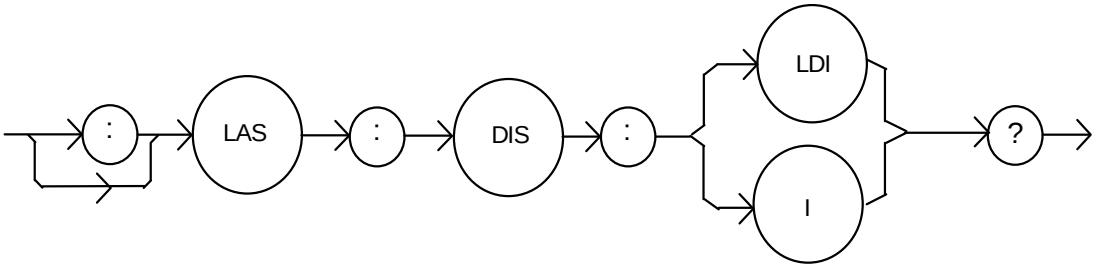
Examples — "LAS:DIS:LDI" -action: enables the display for current values.

LASer:DISplay:LDI?

FRONT PANEL
REMOTE

The LASer:DISplay:LDI? query returns the status of the LDI measurement display mode.

Syntax Diagram



- where the response is 0 or 1.

Notes — In local operation, the status of the LDI measurement display mode is indicated by the enunciator next to the display (mA will be illuminated and not blinking when the display is in LDI measurement mode).

Examples — "LAS:DIS:LDI?" -response: 0, means that the LDI measurement is not displayed.

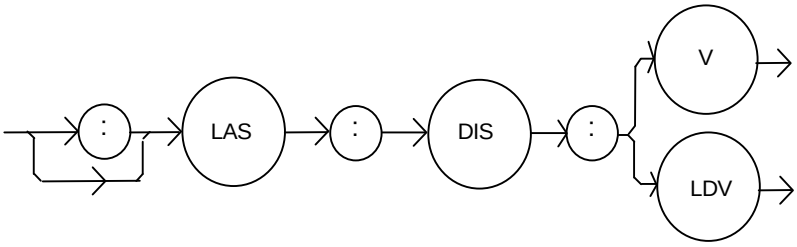
"Las:dis:ldI?" -response: 1, means that the LDI measurement is displayed.

LASer:DISplay:LDV

FRONT PANEL
REMOTE

The LASer:DISplay:LDV command sets the laser display to show the laser forward voltage measurement.

Syntax Diagram



Parameters — None

Notes — The LDV measurement mode is turned off automatically when another display selection is enabled.

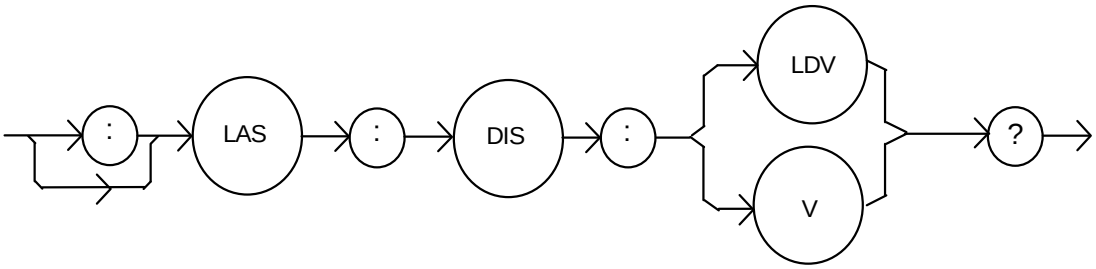
Examples — "LAS:DIS:LDV" -action: enables the display for LDV measurement mode.

LASer:DISplay:LDV?

FRONT PANEL
REMOTE

The LASer:DISplay:LDV? query returns the status of the LDV (laser diode voltage) measurement display mode.

Syntax Diagram



- where the response is 0 or 1.

Notes — In local operation, the status of the LDV measurement mode is indicated by the enunciator next to the display (V will be illuminated when the display is in LDV measurement mode).

Examples — "LAS:DIS:LDV?" -response: 0, means that laser voltage measurement is not displayed.

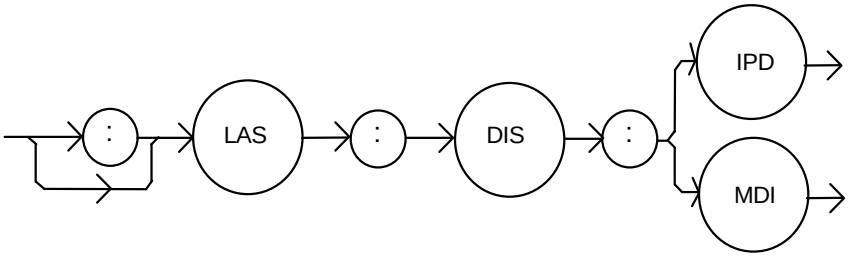
"LAS: DIS:LDV?" -response: 1, means that the laser voltage measurement is displayed.

LASer:DISplay:MDI

FRONT PANEL
REMOTE

The LASer:DISplay:MDI command sets the laser display to show the monitor photodiode current measurement.

Syntax Diagram



Parameters — None

Notes — The MDI measurement display is turned off automatically when another display selection is enabled.

Examples — "LAS:DIS:MDI" -action: enables the display for photodiode current measurement values.

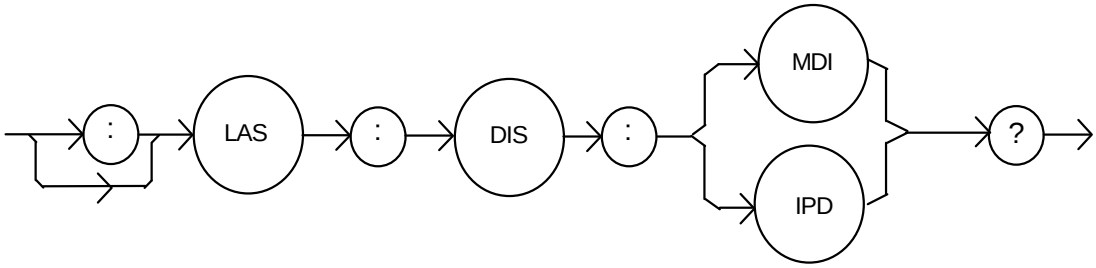
Laser:Disp:Mdi" -action: enables the LASER display for photodiode current measurement values.

LASer:DISplay:MDI?

FRONT PANEL
REMOTE

The LASer:DISplay:MDI? query returns the status of the (LASER DISPLAY) I_{PD} switch.

Syntax Diagram



- where the response is 0 or 1

Notes — In local operation, the status of the MDI measurement mode is indicated by the enunciator next to the display (µA will be illuminated and not blinking when the display is in MDI measurement mode).

Examples — "LAS:DIS:MDI?" -response: 0, means that the laser photodiode monitor current measurement is not displayed.

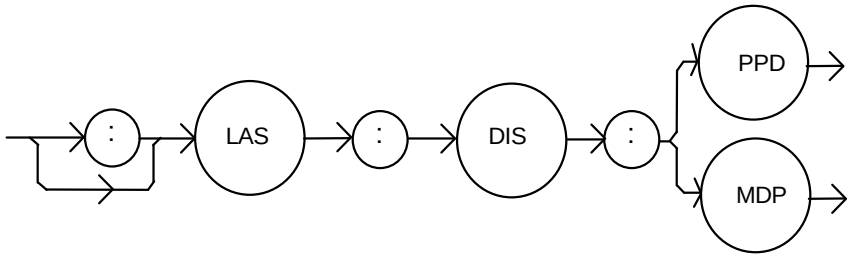
"Las:dis:MDI?" -response: 1, means that the monitor photodiode current measurement is displayed.

LASer:DISplay:MDP

FRONT PANEL
REMOTE

The LASer:DISplay:MDP command sets the display to show the monitor photodiode power measurement.

Syntax Diagram



Parameters — None

Notes — The MDP measurement display is turned off automatically when another display selection is enabled.

Examples — "Las:Display:MDp" -action: enables the display for photodiode power measurement values.

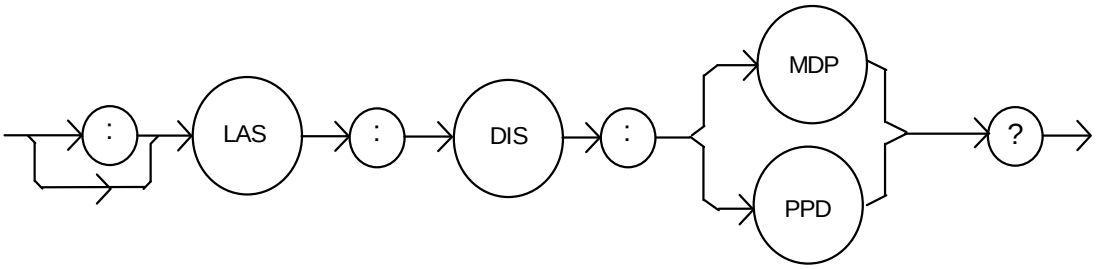
"Laser:Disp:MDP" -action: enables the display for photodiode power measurement values.

LASer:DISplay:MDP?

FRONT PANEL
REMOTE

The LASer:DISplay:MDP? query returns the status of the MDP (monitor diode power) measurement display mode.

Syntax Diagram



- where the response is 0 or 1.

Notes — In local operation, the status of the MDP measurement mode is indicated by the enunciator next to the display (mW will be illuminated and not blinking when the display is in MDP measurement mode).

Examples — "LAS:DISp:MDp?" -response: 0, means that the MDP measurement is not displayed.

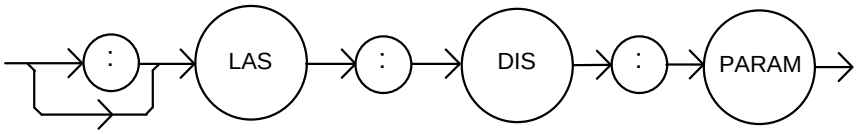
"Las:dis:MDP?" -response: 1, means that the MDP measurement is displayed.

LASer:DISplay:PARAM

FRONT PANEL
REMOTE

The LASer:DISplay:PARAM command enables the display to show the parameter values.

Syntax Diagram



Parameters — None

Notes — This command has the same effect as pressing the (PARAMETER) SELECT switch while in LASER mode. The selected parameter will be displayed for three seconds. The actual LASER PARAM display is turned off automatically when a display selection is enabled.

Each time the command is issued, the next LASER parameter will be selected, see Chapter 2 for more information.

Examples — "Laser:Display:Param" -action: selects a parameter and displays its value.

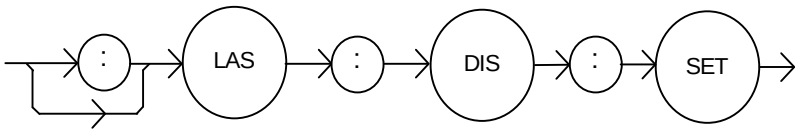
"LAS:DIS:PARAM" -action: selects a parameter and displays its value.

LASer:DISplay:SET

FRONT PANEL
REMOTE

The LASer:DISplay:SET command sets the display to show the setpoint of the selected display mode.

Syntax Diagram



Parameters None

Notes Using this command has the same effect as physically holding the (DISPLAY) SELECT switch down continuously.

Examples "Las:Dis:Set" -action: enables the display for the setpoint of the selected mode: LDI, MDI (I_{PD}) or MDP (P_{PD})

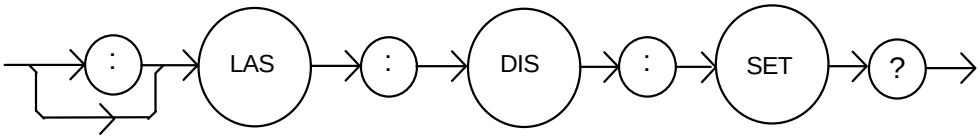
"LAS:Dis:Set" -action: enables the display for the setpoint of the selected display mode.

LASer:DISplay:SET?

FRONT PANEL
REMOTE

The LASer:DISplay:SET? query returns the status of the setpoint display mode.

Syntax Diagram



- where the response is 0 or 1.

Notes The setpoint display will not time out when REMOTE operation is used. (It will be continuously displayed.)

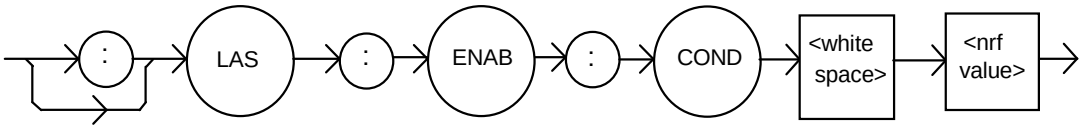
Examples "LAS:DISPLAY:SET?" -response: 0, means the setpoint is not shown on the display.
"Las:Dis:Set?" -response: 1, means the setpoint value is shown on the display.

LASer:ENABle:COND

FRONT PANEL
REMOTE

The LASer:ENABle:COND command sets the condition status enable register of the LASER operations for summary (in bit 3 of the status byte) and generation of service requests.

Syntax Diagram



Parameters An <nrf value> whose sum represents the enabled bits:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output is outside tolerance limit
4	N/A	1024	Output on/off state
8	Power limit	2048	Ready for calibration data state
16	Interlock disabled	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes The enabled or disabled LASER conditions can be read by using the LASer:ENABle:COND? query.

The LASER condition status can be monitored by the LASer:COND? query. If any of the enabled LASER conditions are true, bit 3 of the status byte register will be set.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the GPIB-IEEE488 specification).

Examples "LAS:ENAB:COND 129" -action: enables the LASER status condition register so that the Open circuit and LASER current limit conditions will be summarized in the status byte (bit 3).

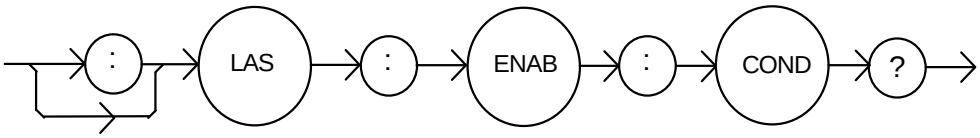
Laser:Enable:Cond #H0F9B" - action: enables the LASER status condition register so that any and all of the above conditions will be reported in the status byte register (bit 3).

LASer:ENABle:COND?

FRONT PANEL
REMOTE

The LASer:ENABle:COND? query returns the value of the status condition enable register of the LASER operations.

Syntax Diagram



- where the response is the sum of the following:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output changed to be in/out of tolerance
4	N/A	1024	Output on/off state
8	Power limit	2048	Ready for calibration data state
16	Interlock disabled	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes The enabled LASER conditions can be set by using the LASer:ENABle:COND command.

The LASER condition status can be monitored by the LASer:COND? query.

Examples "LAS:ENAB:COND?" -response: 17, means that the Laser Current Limit and Interlock disabled LASER conditions will be reported (in summarized form) to the status byte (bit 3).

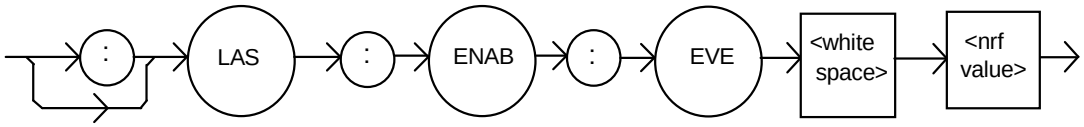
"Radix Hex; Laser:Enable:Cond?" -response: #H0F9B, means that all of the above conditions will be reported (in summarized form) to the status byte (bit 3).

LASer:ENABle:EVEnt

FRONT PANEL
REMOTE

The LASer:ENABle:EVEnt command sets the status event enable register of the LASER operations. These events are summarized in bit 2 of the status byte register.

Syntax Diagram



Parameters An <nrf value> whose sum represents the bits that are enabled:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output changed to be in/out of tolerance
4	N/A	1024	Output on/off state changed
8	Power limit	2048	New measurements taken
16	Interlock changed state	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes The enabled LASER events can be read by using the LASer:ENABle:EVEnt? query. The LASER event status can be monitored by the LASer:EVEnt? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the GPIB-IEEE488 specification).

Examples "LAS:ENAB:EVENT 136" -action: enables the LASER status event register so that the Open circuit and Power limit events will be reported (in summarized form) to the status byte (bit 2).

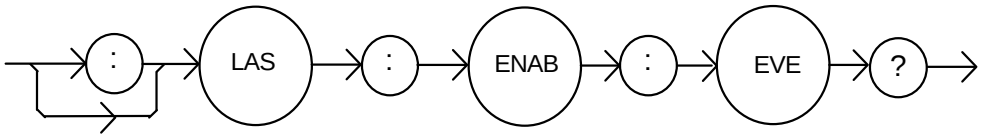
"Laser:Enable:Event #H0F9B" -action: enables the LASER status event register so all of the above events will be reported (in summarized form) to the status byte (bit 2).

LASer:ENABle:EVEnt?

FRONT PANEL
REMOTE

The LASer:ENABle:EVEnt? query returns the value of the status event enable register of the LASER operations.

Syntax Diagram



- where the response is the sum of the following:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output changed to be in/out of tolerance
4	N/A	1024	Output on/off state
8	Power limit	2048	New measurements taken
16	Interlock state changed	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes — The enabled LASER events can be set by using the LASer:ENABle:EVEnt command. The LASER event status can be monitored by the LASer:EVEnt? query.

Examples — "LAS:ENAB:EVE?" -response: 1040, means that the Output on/off state change and Interlock changed LASER events will be reported (in summarized form) to the status byte register (bit 2).

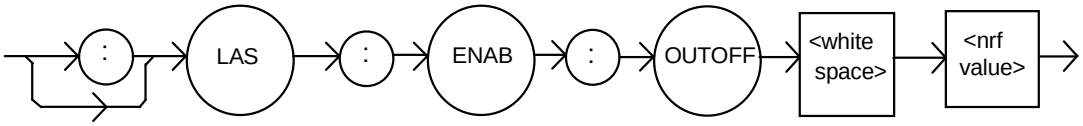
"Radix Hex; Las:Enab:Eve?" -response: #HFDB, means that all of the above events will be reported (in summarized form) to the status byte register (bit 2).

LASer:ENABle:OUTOFF

FRONT PANEL
REMOTE

The LASer:ENABle:OUTOFF command sets the status outoff enable register of the LASER operations (things that will turn the LASER output off).

Syntax Diagram



Parameters An <nrf value> whose sum represents the enabled bits:

1	LASER Current Limit	256	N/A
2	LASER Voltage Limit	512	Output is out of tolerance*
4	N/A	1024	N/A
8	Power limit (with output on)	2048	N/A
16	N/A	4096	N/A
32	N/A	8192	N/A
64	N/A	16384	N/A
128	N/A	32768	N/A

Notes The enabled LASER outoff bits can be read by using the LASer:ENABle:OUTOFF? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the GPIB-IEEE488 specification).

The factory default value for this register is #B0000100000001000, #H808, or 2056 decimal.

Examples "LAS:ENAB:OUTOFF 9" -action: enables the LASER status outoff register so that Power limit and LASER current limit conditions will cause the LASER output to be turned off.

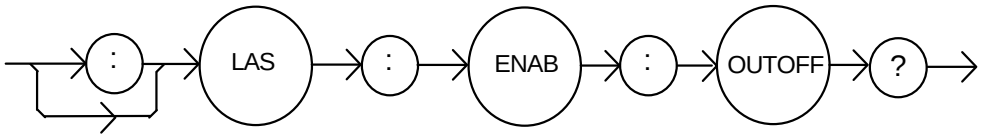
"Las:Enab:Outoff #HE0B" -action: enables the LASER status outoff register so that any or all of the above conditions will cause the LASER output to be turned off.

LASer:ENABle:OUTOFF?

FRONT PANEL
REMOTE

The LASer:ENABle:OUTOFF? query returns the value of the status outoff enable register of the LASER operations.

Syntax Diagram



-where the response is the sum of the following:

1	LASER Current Limit	256	N/A
2	LASER Voltage Limit	512	Output if out of tolerance
4	N/A	1024	N/A
8	Power limit (with output on)	2048	N/A
16	N/A	4096	N/A
32	N/A	8192	N/A
64	N/A	16384	N/A
128	N/A	32768	N/A

Notes — The enabled LASER events can be set by using the LASer:ENABle:OUTOFF command. The LASER output status can be monitored by the LASer:EVEnt? query.

Examples — "LAS:ENAB:OUTOFF?" -response: 1, means that Current Limit Condition will cause the LASER output to be turned off.

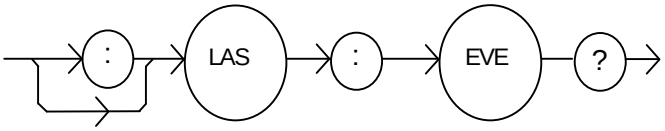
"Radix Hex; Las:Enab:Eve?" -response: #H20B, means that all of the above conditions will cause the LASER output to be turned off.

LASer:EVEnt?

FRONT PANEL
REMOTE

The LASer:EVEnt? query returns the value of the status event register of the LASER operations.

Syntax Diagram



-where the response is the sum of the following:

1	LASER Current Limit	256	Output is shorted
2	LASER Voltage Limit	512	Output changed to be in/out of tolerance
4	N/A	1024	Output on/off state changed
8	Power limit	2048	Measurement ready
16	Interlock disabled	4096	N/A
32	N/A	8192	N/A
64	Compliance Voltage Limit	16384	N/A
128	Open circuit	32768	N/A

Notes

The LASER conditions that are reported in the status byte can be set by using the LASer:ENABle:EVEnt command.

The LASER event status is only cleared when the event status is read or by the *CLS command while the condition status is constantly changing.

Examples

"LAS:EVE?" -response: 513, means that the LASER output tolerance changed and current limit events have occurred since the last LASer:EVEnt? query.

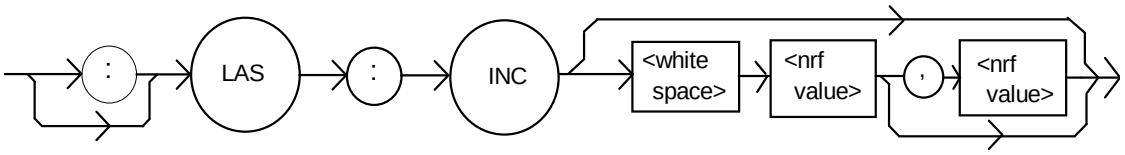
"Radix Hex; Laser:Event?" -response: #H88, means that the LASER Power limit and Open circuit events have occurred since the last LASer:EVEnt? query.

LASer:INC

FRONT PANEL
REMOTE

The LASer:INC command increments the selected laser control mode setpoint by one or more steps. Optional parameters allow multiple steps to be incremented and the time (in ms) between increments to be set, respectively. This is an overlapped command. Other commands may be executed while this function is in progress.

Syntax Diagram



Parameters 0, 1, or 2. The first optional parameter is the number of steps, and the second optional parameter is the number of ms between steps.

Notes The decremental default amount is one step. The step size can be edited via the LAS:STEP command. LDX-3232 default values are 0.1 mA, 0.1 mW, or 1 µA.

If the first optional parameter is used, but not the second, the LASER setpoint is incremented by a multiple of the LAS:STEP size without changing the LAS:STEP size. The second optional parameter is the time, in ms, between steps.

If both optional parameters are used, the user may create an automated stepping ramp function for the LASER output.

If the first optional parameter is entered as zero, “LAS:INC 0”, the command will do nothing.

The minimum time to complete one increment is about 20 ms. Therefore, values for the second optional parameter (time between increments) have a practical minimum of 20.

This command should not be overlapped with “LAS:DEC” or other “LAS:INC” commands.

Examples “LAS:MODE:I; LAS:STEP 3; LAS:INC” -action: The laser source current setpoint is incremented by 0.03 mA.

“LAS:MODE:I; LAS:STEP 3; LAS:INC 3” -action: The laser source current setpoint is incremented by three times the amount described in the first example.

“LAS:MODE:I; LAS:STEP 3; LAS:INC 3,5000” -action: The laser source current setpoint is incremented by the amount described in the first example, three times, with fiveseconds between incremental steps.

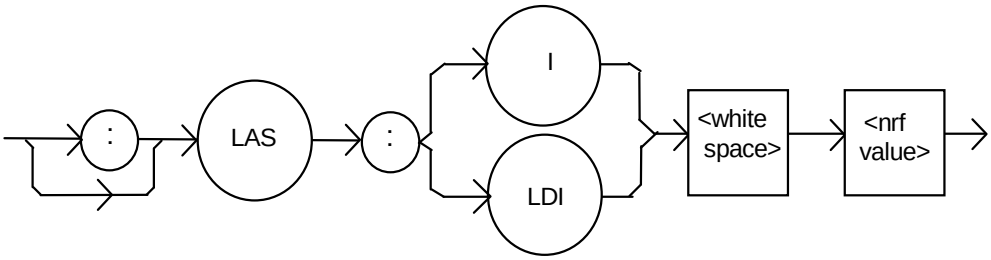
“LAS:STEP 1; LAS:Mode:P; Las:INC” -action: The power setpoint is incremented by 0.01 mW.

LASer:LDI

FRONT PANEL
REMOTE

The LASer:LDI command sets the laser control current.

Syntax Diagram



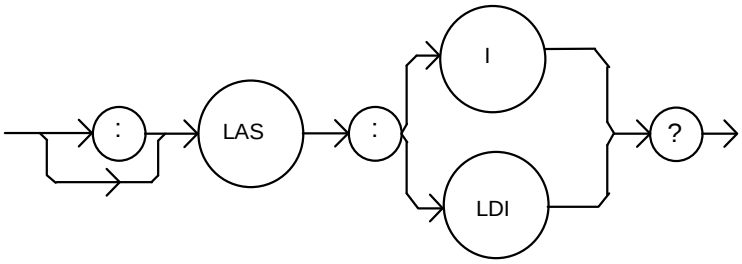
Parameters An <nrf value> that represents the (laser) output current in mA.
Notes setpoint is the same for both low and high bandwidth output modes.
Examples "Las:LDI 400" -action: sets the laser output current to 400.00 mA.
"LAS:ldi 100" -action: sets the laser output current to 100.0 mA.

LASer:LDI?

FRONT PANEL
REMOTE

The LASer:LDI? query returns the value of the measured laser current.

Syntax Diagram



- where the response is the most recent laser current measurement.

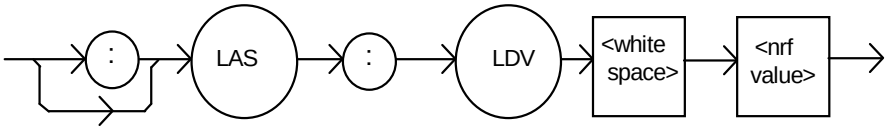
Notes Response is the measured laser output current for either low or high bandwidth modes. This measurement is updated approximately once every 600 ms.
Examples "LAS:ldi?" -response: 30.0, means the measured laser output current is 30.0 mA.
"Laser:LDI?" -response: 100.0, means the measured laser output current is 100.0 mA.

LASer:LDV

FRONT PANEL
REMOTE

The LASer:LDV command sets the laser voltage for calibration of the laser voltage measurement.

Syntax Diagram



Parameters An <nrf value> that represents the (laser) output voltage, in volts.

Notes setpoint is the same for both low and high bandwidth output modes and is entered only for LDV calibration.

Examples "Las:LDV 4" -action: enters a value of 4.000 V.

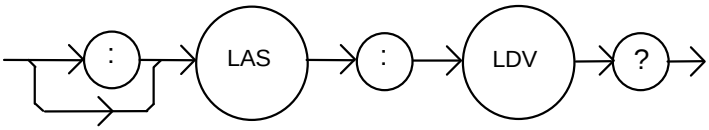
"LAS:ldv 1.025" -action: enters a value of 1.025 V.

LASer:LDV?

FRONT PANEL
REMOTE

The LASer:LDV? query returns the value of the measured laser voltage.

Syntax Diagram



- where the response is the measured laser output voltage for either low or high bandwidth modes.

Notes This measurement is updated approximately once every 600 ms.

Examples "LAS:ldv?" -response: 3.03, means the measured laser output voltage is 3.03 V.

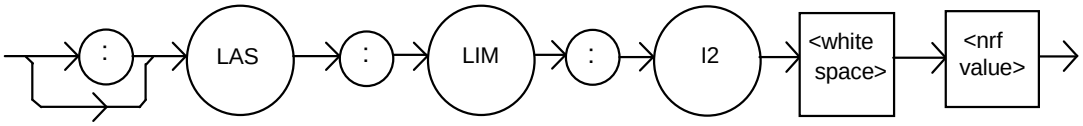
"Laser:LDV?" -response: 1.0, means the measured laser output voltage is 1.000 V.

LASer:LIMit:I2

FRONT PANEL
REMOTE

The LASer:LIMit:I2 command sets the LASER current limit value for the 2000 mA range on the LDX-3232.

Syntax Diagram



Parameters An <nrf value> that represents the LASER limit current, in mA.

Notes The current limit is in effect in all modes of operation (ILBW, IHBW, or P). The current limit in use depends on the LASER output range selection.

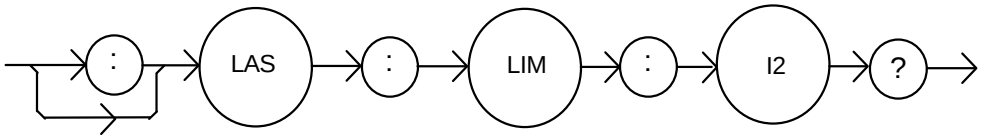
Examples "LAS:LIM:I2 180" -action: the LASER current limit is set to 180 mA.
":Laser:Limit:I2 160" -action: the LASER current limit is set to 160 mA.

LASer:LIMit:I2?

FRONT PANEL
REMOTE

The LASer:LIMit:I2? query returns the value of the LASER current limit for the 2000 mA range on the LDX-3232.

Syntax Diagram



- where the response is the current limit value for the 2000 mA range.

Notes The current limit is in effect in all modes of operation (ILBW, IHBW, or P). The current limit in use depends on the LASER output range selection.

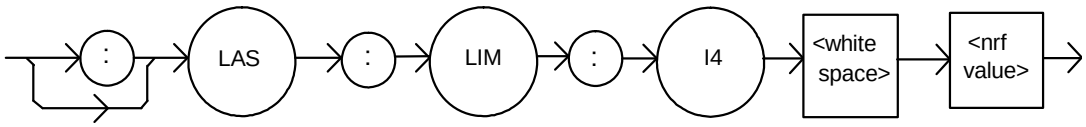
Examples "LAS:LIM:I2?" -response: 40, means the laser current limit is 40 mA.
"Laser:LIM:I2?" -response: 50, means the laser current limit is 50 mA .

LASer:LIMit:I4

FRONT PANEL
REMOTE

The LASer:LIMit:I4 command sets the LASER current limit value for the 4000 mA range on the LDX-3232.

Syntax Diagram



Parameters An <nrf value> that represents the LASER limit current, in mA.

Notes The current limit is in effect in all modes of operation (ILBW, IHBW, or P). The current limit in use depends on the LASER output range selection.

In local operation, the limit current is entered by selecting LIM I parameter, pressing and holding in the (PARAMETER) SET switch, adjusting the knob until the desired value is displayed, and then releasing the SET switch.

Examples "LAS:LIM:I4 1800" -action: the LASER current limit is set to 1800 mA.

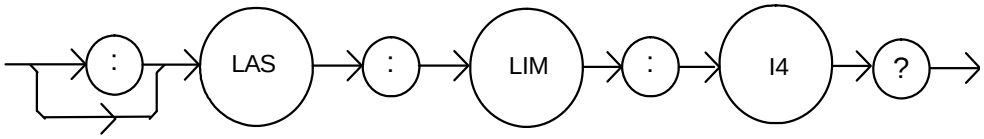
":Laser:Limit:I4 160" -action: the LASER current limit is set to 160 mA.

LASer:LIMit:I4?

FRONT PANEL
REMOTE

The LASer:LIMit:I4? query returns the value of the LASER current limit for the 4000 mA on the LDX-3232.

Syntax Diagram



- where the response is the current limit value for the 4000 mA range.

Notes The current limit is in effect in all modes of operation (ILBW, IHBW, or P). The current limit in use depends on the LASER output range selection.

Examples "LAS:LIM:I4?" -response: 400, means the laser current limit is 400 mA.

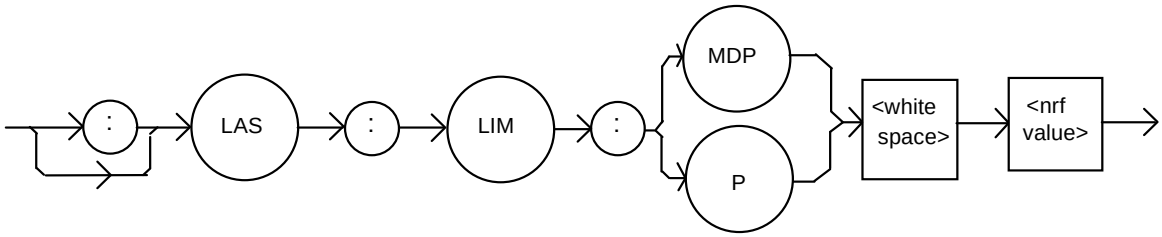
"Laser:LIM:I4?" -response: 1500, means the laser current limit is 1500 mA.

LASer:LIMit:MDP

FRONT PANEL
REMOTE

The LASer:LIMit:MDP command sets the laser monitor photodiode power limit value.

Syntax Diagram



Parameters An <nrf value> that represents the laser monitor photodiode power limit in mW.

Notes When constant MDP mode is used, the output level is limited only by the LIM Ix value. Exceeding the powere limit will either cause the output to shut off (default) or generate a warning (see LAS:ENAB:OUTOFF command).

Examples "LAS:LIM:MDP 10" -action: sets the laser output power limit to a value that corresponds to producing 10.00 mW of photodiode feedback (optical) power.

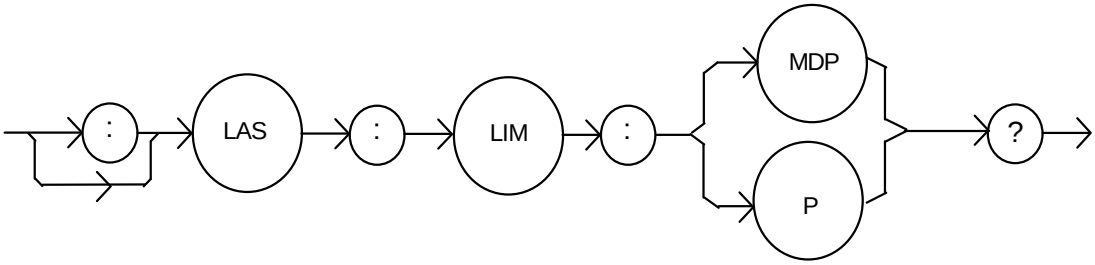
"Las:Limit:MDp 5" -action: sets the laser output power limit to a value that corresponds to producing 5.00 mW of photodiode feedback (optical) power.

LASer:LIMit:MDP?

FRONT PANEL
REMOTE

The LASer:LIMit:MDP? query returns the value of the laser monitor photodiode power limit.

Syntax Diagram



- where the response is the LASER power limit setting.

Notes The (LASER) MDP limit is in effect for both laser output current ranges.

The MDP limit is not in effect when CALMD=0. In this case, the monitor current measurement is not converted to power.

Examples "LAS:LIM:MDP?" -response: 3.0, means the monitor photodiode power limit is set to 3.0 mW.

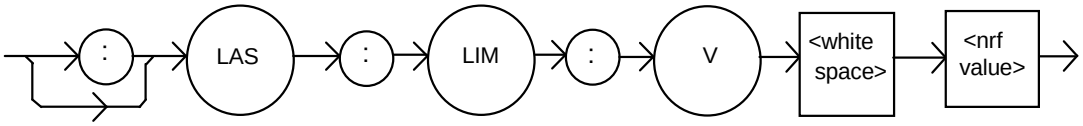
":LAS:Limit:MDP?" -response: 10.0, means the monitor photodiode power limit is set to 10.0 mW.

LASer:LIMit:V

FRONT PANEL
REMOTE

The LASer:LIMit:V command sets the LASER compliance voltage limit value.

Syntax Diagram



Parameters An <nrf value> that represents the LASER limit voltage, in volts.

Notes The voltage limit setting is useful for laser protection. When the maximum operating voltage of a laser is known, the user may set the voltage limit to a value slightly higher than the maximum operating voltage. Then, if the laser is accidentally disconnected, the current source will quickly sense the over-voltage and shut off.

In local operation, the voltage limit is entered by selecting the COMP V parameter, pressing and holding in the (PARAMETER) SET switch. Turn the adjust knob until the desired value is displayed and then release the SET switch.

Examples "LAS:LIM:V 5.0" -action: the LASER compliance voltage limit is set to 5.0 V.

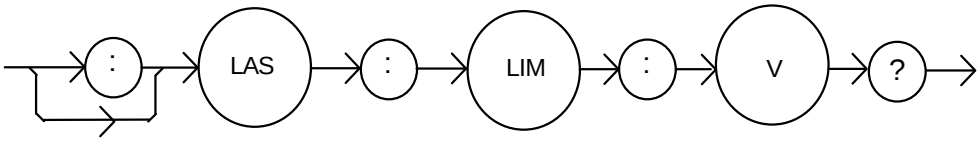
":Laser:Limit:V 4.60" -action: the LASER compliance voltage limit is set to 4.6 V.

LASer:LIMit:V?

FRONT PANEL
REMOTE

The LASer:LIMit:V? query returns the value of the LASER compliance voltage limit setting.

Syntax Diagram



- where the response is the LASER limit voltage setpoint.

Notes The voltage limit is valid for all modes of Laser operation.

In local operation, the voltage limit is seen by selecting the COMP V parameter, pressing and holding in the (PARAMETER) SELECT switch.

Examples "LAS:LIM:V?" -response: 4.5, means the laser compliance voltage limit is 4.5 V.

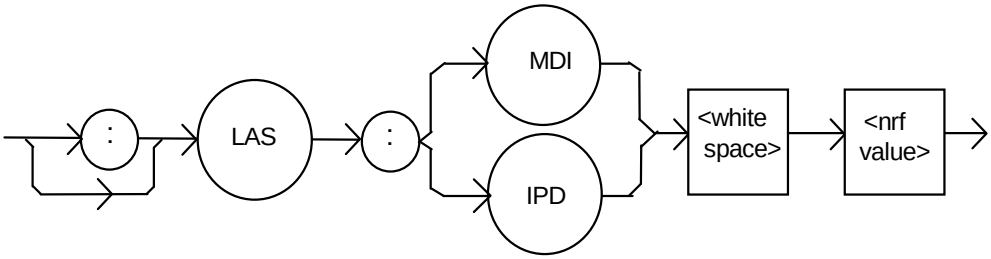
"Laser:LIM:V?" -response: 10.0, means the laser compliance voltage limit is set to 10.0 V.

LASer:MDI

FRONT PANEL
REMOTE

The LASer:MDI command sets the value of the optical power setpoint, in µA, if the CALMD (CAL PD) responsivity is 0.

Syntax Diagram



Parameters An <nrf value> that represents the photodiode feedback current, in µA.

Notes If the CALMD (CAL PD) parameter is not set to 0, the LAS:MDI value will not be used. In this case, the measured MDI would be converted to MDP (P_{PD}, by the CAL PD factor), and the MDP (P_{PD}) setpoint would be used.

Examples "Las:Mdi 40" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 40 µA.

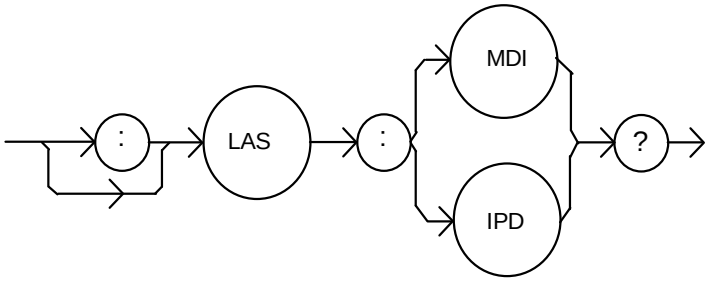
"Laser:MDI 200" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 200 µA.

LASer:MDI?

FRONT PANEL
REMOTE

The LASer:MDI? query returns the value of the laser photodetector current measurement in µA.

Syntax Diagram



- where the response is the most recent LASER monitor current measurement.

Notes The response is in µA. The response is valid, even when the unit is not in constant P mode.

This measurement is updated approximately once every 600 ms.

Examples "Las:Mode:MDP; Las:Calmd 0; Las:MDi?" -response: 100.0, means 100 µA of photodetector current. This feedback is controlling the laser current output.

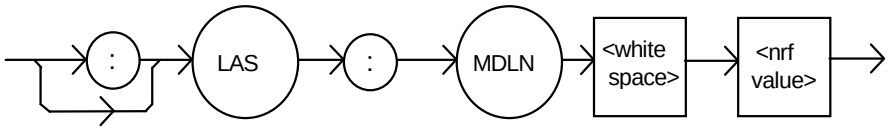
"LAS:MODE:IHBW; LAS:MDI?" -response: 20.0, means 20 µA of photodetector current, but photodiode monitor current is not controlling the laser output current.

LASer:MDLN

FRONT PANEL
REMOTE

The LASer:MDLN command enables or disables (turns off) the front panel modulation input (BNC).

Syntax Diagram



Parameters An <nrf value> - where 1=on, 0=off.

Notes After turning the modulation off, it will remain off until turned back on via this command or by resetting the instrument.

Examples "las:mdln 1" -action: turns the modulation input on and enables modulation via the front panel BNC connector.

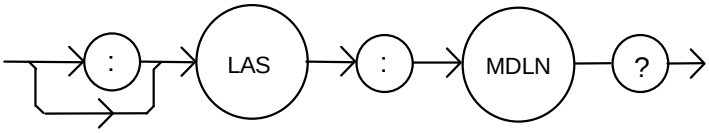
"Laser:mdln 0" -action: turns the modulation input off. Modulation signals at the front panel BNC will not effect the LAS output.

LASer:MDLN?

FRONT PANEL
REMOTE

The LASer:MDLN? query returns that status of the LAS modulation control. When disabled, a modulation signal at the front panel BNC will not effect the LAS output.

Syntax Diagram



- where the response of 1=on, 0=off.

Notes The LASER modulation control switches the front panel BNC in and out of the LAS control circuit. At power up or after reset, modulation is enabled by default.

Examples "LAS:MDLN?" -response: 1, means that the LAS modulation input is enabled.

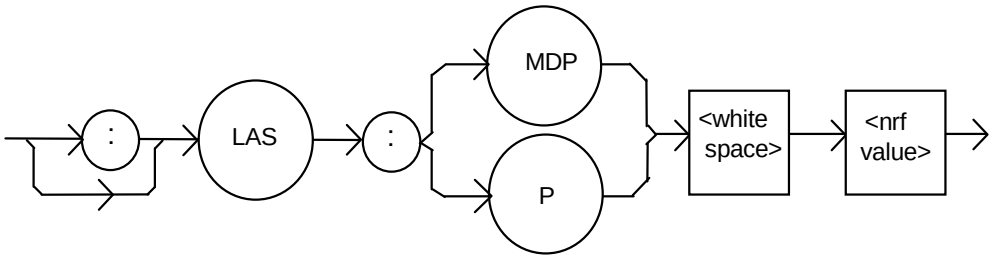
"las:mdln?" -response: 0, means that the LAS modulation input is disabled.

LASer:MDP

FRONT PANEL
REMOTE

The LASer:MDP command sets the value of the optical power setpoint in mW if the CALMD (CAL PD) responsivity is greater than 0.

Syntax Diagram



Parameters An <nrf value> that represents the photodiode feedback power in mW.

Notes If the CALMD (CAL PD) parameter is set to 0, the LAS:MDP value will not be used. In this case, the measured MDP would be invalid, and the MDI (I_{PD}) setpoint would be used.

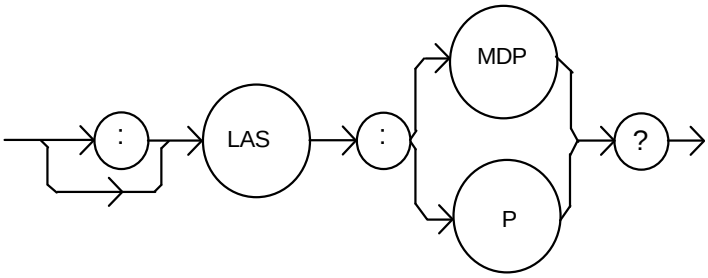
Examples "Las:Mdp 40" -action: The LASER output is controlled so that the photodiode feedback power remains constant at 40 mW.

"Laser:MDP 200" -action: The LASER output is controlled so that the photodiode feedback power remains constant at 200 mW.

LASer:MDP?

FRONT PANEL
REMOTE

The LASer:MDP? query returns the value of the laser photodetector power measurement in mW.



- where the response is the most recent LASER power measurement.

Notes The response is in mW. The response is valid, even when the unit is not in constant P mode. This measurement is updated approximately once every 600 ms.

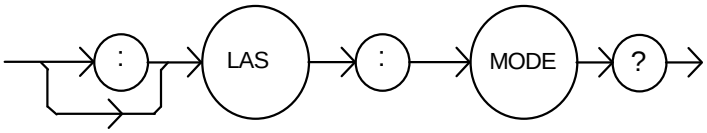
Examples "Las:Mode:MDP; Las:Calmd 460; Las:MDp?" -response: 100.0, means 100 mW of photodetector power. This feedback is controlling the laser current output.

"LAS:MODE:IHBW; LAS:MDP?" -response: 20.0, means 20 mW of photodetector power, but photodiode monitor current is not controlling the laser output current.

LASer:MODE?

FRONT PANEL
REMOTE

The LASer:MODE? query returns the selected laser control mode.



Notes I_{HBW} mode is the same as I mode (low bandwidth), except that the output low bandpass filter is disabled in I_{HBW} mode.

Examples "LAS:MODE?" -response: ILBW, means that constant I (current) mode is in effect for the laser output.

":Las:Mode?" -response: MDP, means that constant P (power) mode is in effect for the laser output, and CALMD>0.

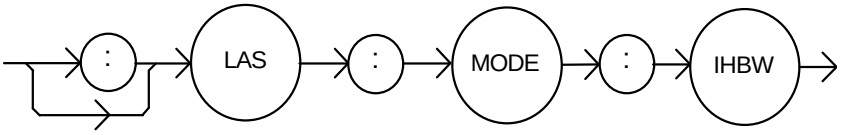
"Las:Mode?" -response: MDI, means that constant P (power) mode is in effect for the laser output, and CALMD=0.

"Laser:MODE?" -response: IHBW, means that constant I_{HBW} (current, high bandwidth) mode is in effect for the laser output.

LASer:MODE:IHBW

FRONT PANEL
REMOTE

The LASer:MODE:IHBW command selects laser high bandwidth constant current mode.



Parameters None

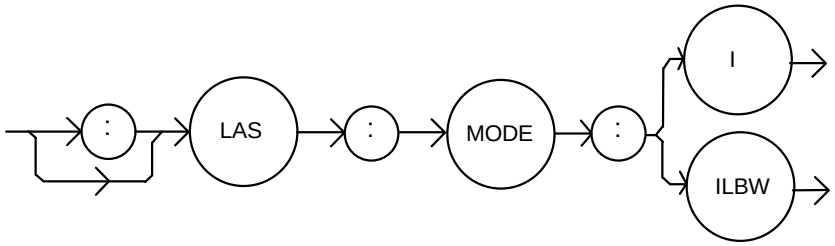
Notes This mode of operation is constant I mode with the output lowpass filter disabled.

Examples "LAS:Mode:Ihbw" -action: enables the laser high bandwidth constant current mode.

LASer:MODE:ILBW

FRONT PANEL
REMOTE

The LASer:MODE:ILBW command selects laser constant current mode.



Parameters None

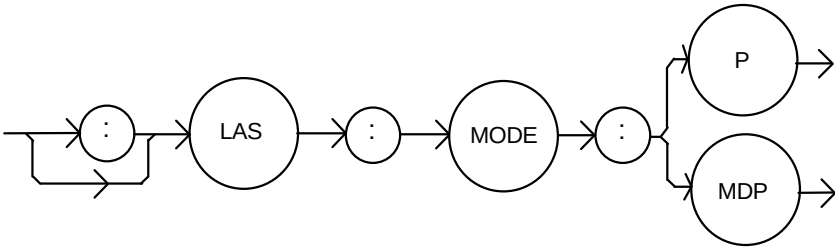
Notes Constant I mode (low bandwidth) enables the output low bandpass filter.

Examples "LAS:MODE:ILBW" -action: sets the laser output for constant I mode (low bandwidth).

LASer:MODE:MDP

FRONT PANEL
REMOTE

The LASer:MODE:MDP command selects laser constant power mode.



Parameters None

Notes This mode of laser operation requires the laser's monitor photodiode feedback to maintain constant optical power or constant monitor current.

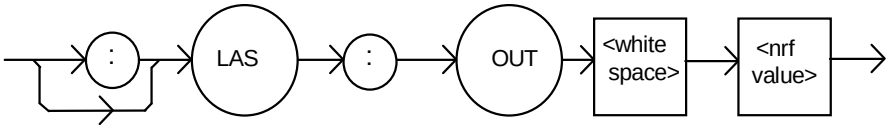
In this mode, the displayed parameter will be either I_{PD} (if CALMD=0) in µA, or P_{PD} (if CALMD>0) in mW.

Examples "LAS:MODE:MDP" -action: sets the laser output mode of operation to constant optical power mode.

LASer:OUTput

FRONT PANEL
REMOTE

The LASer:OUTput command turns the laser output on or off.



Parameters — An <nrf value>; 1=on, 0=off.

Notes — There is a two-second delay after the output is turned on before the output shorting relay is opened. Following this, the output current ramps up to the current setpoint slowly to protect the laser. Therefore, the time to turn the output on and reach the setpoint current varies from two to about three seconds.

After the output is turned on, it may be useful to wait until the output is stable (within tolerance) before performing further operations, but it is not necessary. When the LASER output is off, it is safe to connect or disconnect devices to the LASER output terminals.

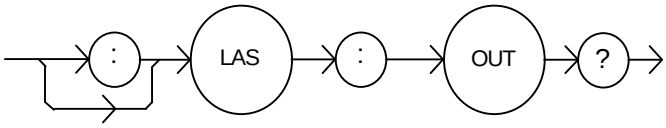
When the LASER output is off, an internal short is placed across the output terminals.

Examples — "LAS:I 20; LAS:OUT ON" -action: sets the laser output current to 20 mA and then turns the output on.

LASer:OUTput?

FRONT PANEL
REMOTE

The LASer:OUTput? query returns the status of the laser output switch.



- where the response is 0 or 1

Notes — Although the status of the switch is on, the output may not have reached the setpoint value.

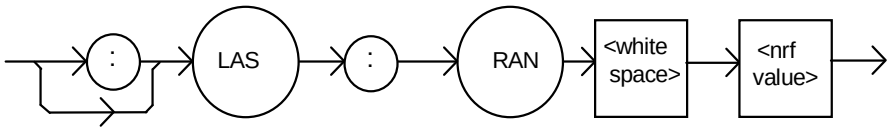
Examples — "Las:OUT?" -response: 0, means that the output switch is disabled, devices may be safely disconnected or connected at the LASER output terminals.

"LAS:OUT?" -response: 1, means that the LASER output switch is enabled, LASER output is present.

LASer:RANge

FRONT PANEL
REMOTE

The LASer:RANge command selects the laser's drive current output range.



Parameters — An <nrf value> that represents the laser current output range.
2 = 2000 mA, and 4= 4000 mA range

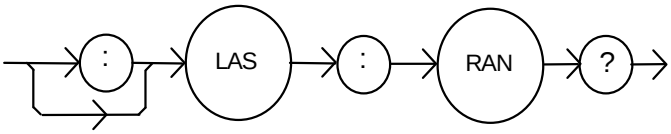
Notes — This range setting effects the Laser Drive Current output current range only. The Laser Drive Current output should be “off” when this command is issued. If the Laser Diode Current output is “on” when this command is issued, the LDX-3232 will generate error E515, and the range will not be changed.

Examples — "LAS:RAN 4" -action: sets the laser output drive current range to 4000 mA.
"Laser:range 2" -action: sets the laser output drive current range to 2000 mA.

LASer:RANge?

FRONT PANEL
REMOTE

The LASer:RANge? query returns the value of the Laser Drive Current range.



- where the response is in integer; 2 means 2000 mA range and 4 means 4000 mA range.

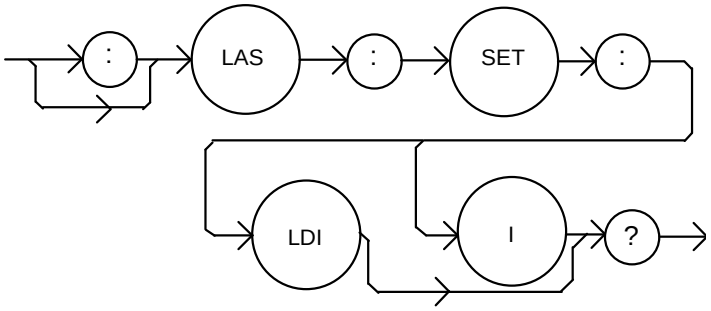
Notes — The resolution and accuracy of the laser limit current are dependent on the Laser Drive Current output range.

Examples — "LAS:RAN?" -response: 2, means that the Laser Drive Current range is 2000mA.
"LAS:range?" -response: 4, means that the Laser Drive Current range is 4000mA.

LASer:SET:LDI?

FRONT PANEL
REMOTE

The LASer:SET:LDI? query returns the constant I value that is used for both output ranges and both bandwidths.



- where the response is the constant I setpoint value, in mA.

Notes — In local operation, the constant I setpoint is read by selecting I or I_{HBW} mode, then pressing and holding down the SELECT switch in the DISPLAY area of the front panel. When the mA indicator is blinking, the display will show the LDI setpoint.

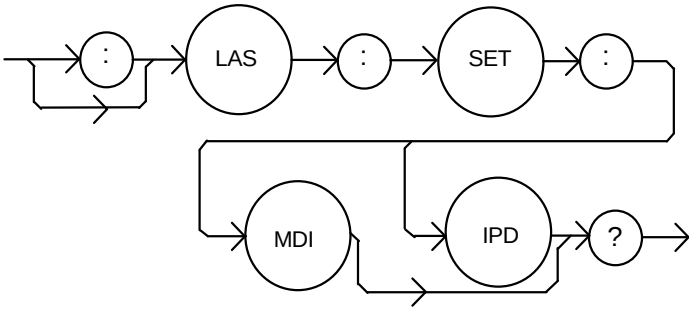
Examples — "LAS:SET:LDI?" -response: 50.0, means the laser output current setpoint value is 50.0 mA.

"Laser:set:ldi?" -response: 120.0 means the laser output current setpoint value is 120.0 mA.

LASer:SET:MDI?

FRONT PANEL
REMOTE

The LASer:SET:MDI? query returns the laser monitor photodiode current setpoint value (when CALPD=0), in µA.



- where the response is the constand I_{PD} setpoint value, in µA.

Notes — In local operation, the MDI setpoint is read by selecting P mode, then pressing and holding down the SELECT switch in the DISPLAY area of the front panel. When the µA indicator is blinking, the display will show the MDI setpoint.

The monitor photodiode current is directly proportional to the laser optical output power. Therefore, the MDI (I_{PD}) setpoint may be used to control optical output of the laser.

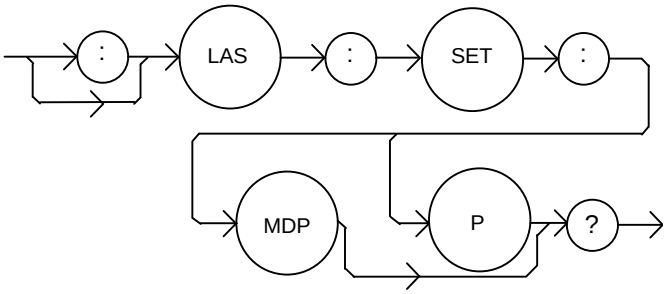
Examples — "las:set:mdi?" -response: 30.0, means the laser monitor photodiode current is setpoint is 30 µA, for use in constant P mode with CALPD = 0.

"LAS:Set:MDI?" -response: 100.0 means the laser monitor photodiode current is setpoint is 100 µA, for use in constant P mode with CALMD=0.

LASer:SET:MDP?

FRONT PANEL
REMOTE

The LASer:SET:MDP? query returns the laser monitor photodiode power setpoint value (when CALMD [CAL PD] is not zero), in mW.



- where the response is the constand P_{PD} setpoint, in mW.

Notes — In local operation, the MDP setpoint is read by selecting P mode, then pressing and holding down the SELECT switch in the DISPLAY area of the front panel. When the mW indicator is blinking, the display will show the MDP setpoint. This setpoint is used in constand MDP mode only.

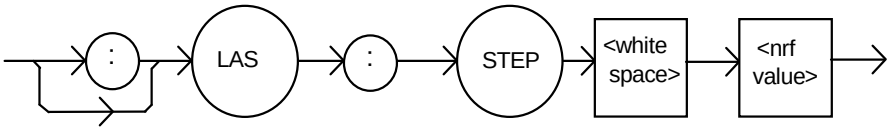
Examples — "LAS:Set:MDP?" -response: 10.0, means the laser monitor photodiode feedback setpoint is 10.0 mW (CALPD>0).

"Laser:Set:MDP?" -response: 25.0, means the laser monitor photodiode feedback setpoint is 25.0 mW (CALPD>0).

LASer:STEP

FRONT PANEL
REMOTE

The LASer:STEP command is used to increment or decrement the selected laser control mode setpoint by the given amount, when used with the LASer:INC or LASer:DEC command.



Parameters — An integer value of the step amount, in the range 1 to 9999.

Notes — The step of one corresponds to the smallest display resolution for the mode. For example, a step of one means 0.1 mA, 0.1 mW, or 1 µA (if CALPD=0).

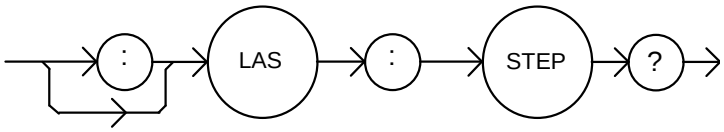
Examples — "Las:Mode:i; Las:Idi 20; Las:Step 100; Las:Inc; Las:set:Idi?" -action: sets the step to 10.0 mA, so the Las:set:Idi? query will return a value of 21.0 mA.

"LAS:STEP 100" -action: sets the step size to 100; could mean 10.0 mA , 10.0 mW, or 100 µA.

LASer:STEP?

FRONT PANEL
REMOTE

The LASer:STEP? query is used to read back the LASer STEP value. This value is used to increment or decrement the selected laser control mode setpoint by the given amount when used with the LASer:INC or LASer:DEC command.



- where the response is an integer value.

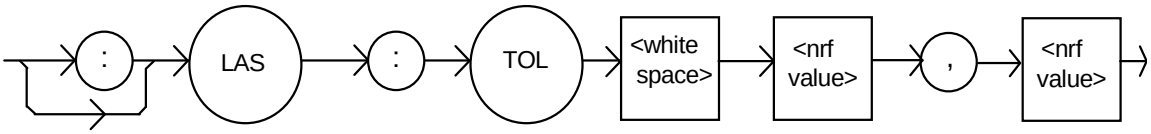
Examples "Las:Mode:LDI; Las:Step?" -response: 1 means the step size is 0.1 mA, since Const I mode is in effect.

"LAS:MODE:MDP; LAS:CALMD 1; LAS:STEP?" -response: 10 means the step size is 1.0 mW, since Const P mode is in effect.

LASer:TOLerance

FRONT PANEL
REMOTE

The LASer:TOLerance command allows the programmer to determine the LASER current tolerance and time window for it to occur, in order that the operation complete flag be set after a "LASer:OUTput 1" command is issued or the LASER setpoint is changed.



Parameters Two <nrf values>; the first represents the LASER current tolerance in mA with a range of 0.1 to 100.0 mA; and the second represents the time window, in seconds, with a range of 0.001 to 50.000 seconds.

Notes The LDX-3232 defaults to a tolerance of 1.0 mA for three seconds, unless changed by the LASer:TOLerance command.

If the LDX-3232 is operated in P mode, the current tolerance parameter is not used. Instead a fixed value of 50 µA is used for the I_{PD} current. A fixed value of 1 mW is used for P_{PD} power, and only the time window parameter may be adjusted.

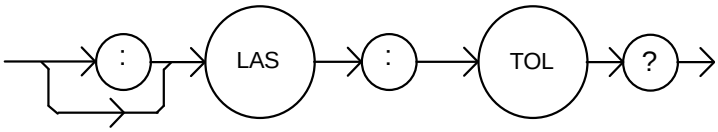
Note: If the tolerance is set too tight it may never be achieved. This is due to the calibration of the setpoint and measurement values.

Examples "Las:Tol 0.5,10" -action: the LDX-3232's LASER current source will be in tolerance when the LASER current is within 0.5 mA for 10.000 seconds.

LASer:TOLerance?

FRONT PANEL
REMOTE

The LASer:TOLerance? query allows the programmer to determine how the LASER current tolerance is set.



- where the response consists of two values, the first is the current tolerance in mA and the second is the time window, in seconds.

Notes — The tolerance of the LDX-3232 LASER current may be used to delay programming after an "LASer:OUTput 1" command is issued or the setpoint is changed.

A change of the output into or out of tolerance flag sets a flag in the LASER status event register and so entering or exiting LASER current tolerance may be used to generate service requests.

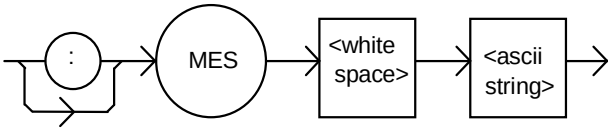
Examples — "Las:Tol?" -response: "0.2,5.0", means the LDX-3232 has a LASER current tolerance setting of 0.2 mA with a time window of 5.000 seconds.

"LASER:TOL?" -response: "1.0,20.0", means the LDX-3232 has a LASER current tolerance setting of 1.0 mA with a time window of 20.000 seconds.

MESsage

FRONT PANEL
REMOTE

The MESsage command allows the user to enter an ASCII string of up to 16 non-NULL characters. This command may be useful for storing messages that relate to a test or configuration.



Parameters — An ASCII string that is 1 - 16 bytes in length.

Notes — The message may contain any ASCII character, but will be terminated when a NULL terminator character is received. If the message has less than 16 bytes, the software will fill the remaining message space with the space character. After 16 bytes have been entered, the software will null-terminate the string.

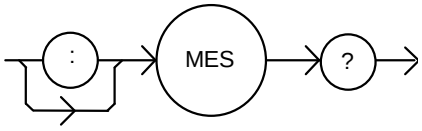
Examples — MESSAGE "This is a test." -action: The string, "This is a test. " will be stored in non-volatile memory.

Mes "Test 3" -action: The string, "Test 3 " will be stored in non-volatile memory.

MESsage?

FRONT PANEL
REMOTE

The MESsage? query returns the previously stored message. This message will always be 16 bytes long and enclosed in quotes. The message is entered via the MESsage command.



- where the response is a 16-byte long character string.

Notes — The response data will be a 16-byte long string. If there is no previously stored message, the response will be " ", all spaces.

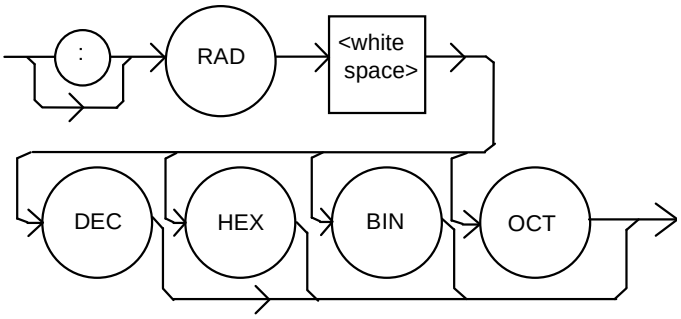
Examples — "MES?" -response: "Test 3 ", means the previously stored message was "Test 3".

"Message?" -response: "This is a test. ", means the previously stored message was "This is a test."

RADix

FRONT PANEL
REMOTE

The RADix command allows the programmer to select the radix type for status, condition, and event query response data. Decimal, binary, hexadecimal, and octal are allowed.



Parameters — As shown above, character program data is expected.

Notes — DECimal is the default type. Only the first three letters of the words decimal, hexadecimal, binary, or octal are required.

When the RADIX is selected, all status, condition, and event queries will return values in the new radix.

In the cases where the radix is not DECimal, the flexible numeric type <nrf value> (as shown in the Command Reference diagrams) will be replaced by HEX, BIN, or OCT representation.

All of the above radixes may be used to enter program data at any time, without the need for issuing the RADix command. The proper prefix must also be used with Hex (#H), binary (#B), or octal (#Q).

This command may be useful for setting up status reporting blocks. The bit-wise status representation may be more easily read in BIN, HEX, or OCT.

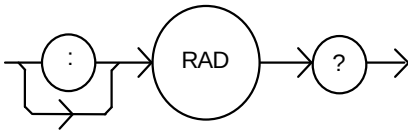
Examples — "RAD dec" -action: the decimal radix is selected.

"rad hex; *ESR?" -action: the hexadecimal radix is selected; -response: #H80, means power-on was detected.

RADix?

FRONT PANEL
REMOTE

The RADix? query allows the programmer to determine that radix type for status, condition, and event query response data is currently selected. Decimal, binary, octal, and hexadecimal are allowed.



- where the character response data of DEC means decimal, BIN means binary, HEX means hexadecimal, and OCT means octal.

Notes DEC is the default type. The LDX-3232 defaults to this radix at power-up.

The RADix command is used to select the desired radix. Once it is changed, the new radix will remain in effect until the power is shut off or a new RADix command is issued.

Examples "RAD?" -response: Dec, means the selected radix is decimal.

"rad?" -response: Hex, means the selected radix is hexadecimal.

"RADIX?" -response: Oct, means the selected radix is octal.

SECURE

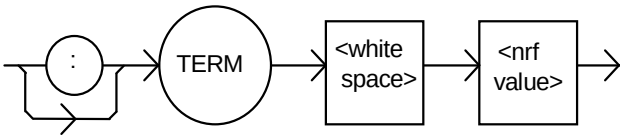
FRONT PANEL
REMOTE

The SECURE command allows the service technician access to the protected user data command, *PUD, that is a common command. This data is normally changed only at the factor, and therefore the SECURE command is not needed by the user.

TERM

FRONT PANEL
REMOTE

The TERM command allows the programmer to change the default (GPIB/IEEE488 standard) terminator to include the carriage return.



Parameters An <nrf value>, 0=FALSE, non-zero=TRUE

Notes An altered terminator will be in the form <CR><NL><^END>. This technically takes the LDX-3232 out of GPIB/IEEE488 specification, but may be done for convenience when using non standard GPIB controllers. This termination will be sent with all output until the "TERM 0" command is sent or the LDX-3232 is powered off.

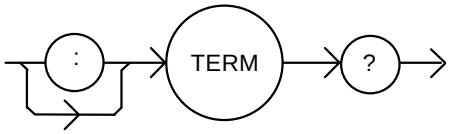
Examples "Term 1" -temporarily sets <CR><NL><^END> as the output terminator.

"Term 0" -sets the GPIB/IEEE488 standard <NL><^END>terminator. This is the LDX-3232 default value.

TERM?

FRONT PANEL
REMOTE

The TERM? query allows the programmer to determine whether the default (IEEE488.2 standard) terminator has been altered to include a carriage return.



- where the response is 0 or 1.

Notes — An altered terminator will be in the form <CR><NL><^END>. This termination will be sent with all output until the "TERM 0" command is sent, or the LDX-3232 is powered off.

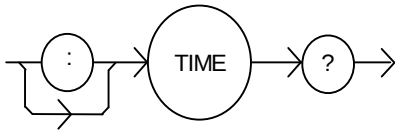
Examples — "Term?" -response: 1, means that the <CR><NL><^END> terminator is temporarily being used.

"Term?" -response: 0, means that the <NL><^END> terminator (GPIB/IEEE488 standard) is being used.

TIME?

FRONT PANEL
REMOTE

The TIME? query allows the programmer to determine how much time has passed since the LDX-3232 was last powered up.



- where the response is character data in the form: hours:minutes:seconds.

Notes — The TIME clock is independent of the TIMER clock.

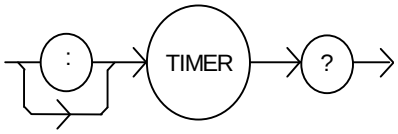
Examples — "Time?" -response: 1:02.36, means that one minute and 2.36 seconds have passed since the LDX-3232 was powered up.

"TIME?" -response: 32:00:76, means that 32 minutes and 0.76 seconds have passed since the LDX-3232 was powered up.

TIMER?

FRONT PANEL
REMOTE

The TIMER? query allows the programmer to determine how much time has passed since the last TIMER? query was issued.



- where the response is character data that represents hours:minutes:seconds.

Notes

Each time the TIMER? query is issued, the timer is reset to 0 and the elapsed time since the last TIMER? query is returned.

The timer counter is initially set at power-up, the same as the TIME? counter. So the first time the TIMER? is issued its response will be the same as if a TIME? query's response.

Examples

"Timer?" -response: 00:02:00.31, means the LDX-3232 has been on for two minutes and 0.31 seconds since the last TIMER? query was issued.

"TIMER?" -response: 00:00:12.03, means the LDX-3232 has been on for 12.03 seconds since the last TIMER? query was issued.

CHAPTER 5

FUNCTIONS AND FEATURES

This chapter introduces you to the LDX-3232 High Compliance Current Source functions and operating features such as event triggering, analog modulation of laser injection current, and Save and Recall.

Saving and Recalling from the Front Panel

For applications where you might need to alternate between particular instrument configurations, the LDX-3232 Current Source offers a unique SAVE and RECALL feature. The SAVE feature allows you to easily store all front panel settings for any given instrument configuration. These settings, that are stored in one of ten memory bins, can be retrieved at any time with the RECALL function. This saves setup time, and it reduces the chance of setup error for tests that are periodically repeated. For example, using the configuration described in Chapter 2 where the Current Source is operating in Constant Current mode, the instrument parameters saved by using the SAVE function would be Constant Current Mode, 2000 mA range, a limit setpoint of 1750 mA, a laser current setpoint of 1500 mA, and Display Mode I. Once this setup is saved, the LDX-3232 Current Source may be configured for another unique setup. You can recall the original setup for the first experiment any time using the RECALL function.

To enter the SAVE/RECALL mode, press the SELECT switch in the PARAMETER section until the SAVE indicator LED becomes lit and the unit displays the SAVE "bin" on the display. If another bin number is desired, press and hold the SET switch and rotate the adjust knob until the desired bin number is displayed. Releasing the SET switch completes the SAVE operation and all of the instrument parameters are saved to the indicated bin number as they appear on the front panel.

To recall a previously saved instrument setup, press the SELECT switch until the RECALL indicator led becomes lit. The instrument will display a RECALL "bin" number on the display. If you desire to change the RECALL bin, press and hold the SET switch and rotate the adjust knob until the desired bin number is displayed. Releasing the SET switch completes the RECALL operation. The instrument is restarted and the front panel parameters are reconfigured to the new parameters saved under that bin number.

The factory default values for front panel parameters may be restored by recalling "bin" zero (0). See Table 2.1 for the default settings.

Saving and Recalling Under Remote Operation

For saving under remote operation, use the command `*SAV` x, where x is the desired "bin" number (1-10). For a recall under remote operation, use the command `*RCL` x, where x is the desired "bin" number (0 - 10).

Using the Laser Compliance Voltage Adjustment

For applications where you need to have critical protection of the laser, we recommend the following. Using a 1 Ω resistor or other non-critical load, set the LASER voltage limit as described in Chapter 2.

Then with the LASER output on, slowly increase the LASER current and watch the LASER voltage measurement. Press the (DISPLAY) SELECT push button to see the voltage. At about 0.25 V below the LASER voltage limit value, the VOLTAGE LIMIT warning indicator will become lit on the display. Continue to adjust the current upwards until the voltage limit is reached and the output is shut off. Record the voltage at that the LASER output shuts off. It should be within the specification of the LASER voltage limit accuracy. However, there is typically some offset error. For example, if the LASER voltage limit is set to 5.0 V, the actual voltage where it shuts off may be 4.9 V. This error term of 0.1 V should be considered when setting the LASER compliance voltage limit.

The closer the LASER voltage limit shut off point is to the operating voltage of your laser, the faster the circuit will work in the event of an open circuit. Some experimentation may be necessary for optimum results.

Using the LDX-3232 Current Source's Trigger Function

For applications where you need to synchronously initiate a measurement task from a remote instrument with the LDX-3232 Current Source, the Current Source offers a trigger output signal. The TTL pulse is initiated with any remote change in setpoint of the laser current source. A typical application for utilization of this feature is laser characterization tasks where an L-I curve is generated. For a programmed step in laser current, a light measurement can be triggered for each step in laser current. The trigger output is enabled only in remote mode via the GPIB/IEEE 488 GPIB Interface.

The trigger output is available via a standard BNC connector on the rear panel of the LDX-3232 Current Source. See Figure 5.1. The TTL pulse is approximately 13 µs wide and has a delay time of about 10-12 ms after the current setpoint is changed via GPIB. This delay does not include the GPIB transmission time. The time for any command to be sent via GPIB depends on the interface hardware and software control. The current setpoint may be changed by the LAS:LDI, LAS:INC, or LAS:DEC commands.

Note: The minimum step change time required for a corresponding trigger pulse is 20 ms. Care should be used with respect to the timing of any setpoint commands in relation to the actual hardware function. The INC and DEC commands have a minimum step time of about 20 ms that allows for the hardware initiation of a setpoint change and the settling of the output. The LAS:LDI command does not have any fixed delay for settling. With this command, some trigger pulses may be missed if the program step time is less than the 20 ms minimum.

A one shot trigger pulse will occur on power up of the instrument due to the states of the processor I/O.

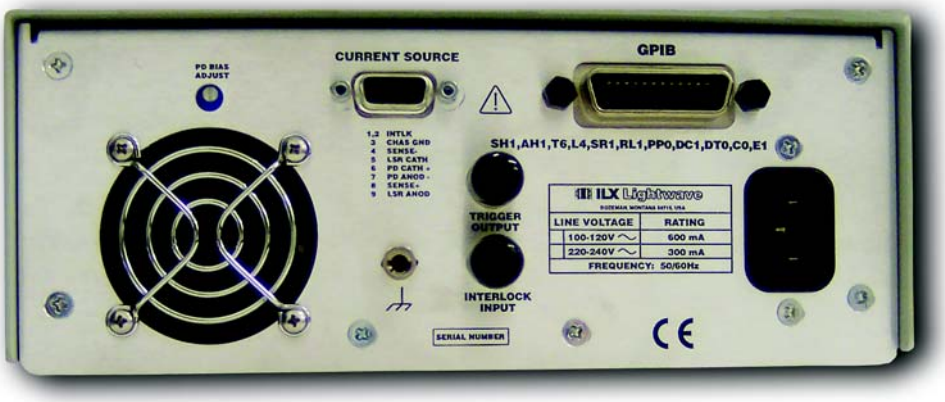


Figure 5.1 LDX-3232 Rear Panel

Using the LDX-3232 Current Sources's BNC Interlock Connection

The LDX-3232 BNC interlock connection is designed to allow an external emergency input signal to turn the current output off. The BNC interlock is TTL compatible and configured to be normally closed (as opposed to the DB-9 interlock connection, that is normally open). The BNC interlock connection, when left unconnected, is pulled to a logic high with a 100 kΩ resistor. High values (+5 V) will keep the interlock closed (current source in the operational state), while low values (0 V) will open the BNC interlock (forces the output off). Once the BNC interlock is opened, the output will stay off until the interlock is closed again, and you re-enable the output.

BNC Interlock Usage Example

When using the LDX-3232 Current Source to drive a temperature controlled laser diode, the BNC interlock can be used to accept an error signal from the laser diode temperature controller unit. Linking the LDX-3232 Current Source to a temperature controller* with the ability to signal when its temperature control has gone outside of some tolerance window will allow the LDX-3232 to safely shutoff its output before thermal damage occurs to the laser diode.

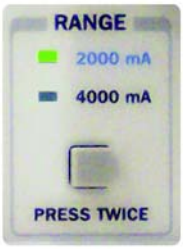
*The ILX Lightwave LDT-5900 series of temperature controllers include an output BNC connector that is compatible with the BNC interlock feature of the LDX-3232. The output BNC connector of the LDT-5900 has a TTL compatible output signal that will signal when the temperature control has gone outside of a programmable temperature window. For more information about the LDT-5900 series of temperature controllers, please call 1-800-459-9459 (USA or Canada only), 1-406-556-2481 (International), or go to www.ilxlightwave.com.

Modulating the Laser Current Source

The LDX-3232 Current Source allows a modulated signal to be superimposed on the source output current. For example, assume you are using an LED for your experiment where you need to operate the LED in constant current at P_{OP} = 100 mW, with a modulated signal from 3 to 30 kHz. The experiment requires the LDX-3232's laser Current Source to be configured for the 2000 mA range, high bandwidth mode with a limit of 1750 mA. The allowable bandwidth of the modulated analog signal, defined as the 3 dB roll off point, is dependent on the output current range and the mode (constant current low/high bandwidth). See the section, LASER CURRENT SOURCE SPECIFICATIONS, in Chapter 1 for external analog modulation bandwidth specifications.

Setting up the Current Source for a modulated laser injection current is easy. The (MOD) EXTERNAL connector (BNC) on the front panel is the input for the modulated signal. Connect a modulating voltage signal from a standard function generator, for example, to this connector. The modulation port input impedance is 1 kΩ. The transfer function for the low and high current ranges of the LDX-3232 are 200 mA/V and 400 mA/V.

Set the LDX-3232 in Constant Current High Bandwidth Mode by selecting I_{HBW} in the MODE section of the front panel. Do this by toggling the (MODE) SELECT push button until the I_{HBW} indicator is illuminated. Repeatedly pressing the (MODE) SELECT switch cycles through the current (I), optical power (P), or high bandwidth current (I_{HBW}) control modes.



Next, set the current source range by selecting the 2000 mA range indicated by the accompanying LED. You will need to press the select push button twice to change the range. It must be pressed twice quickly (within less than one second) to switch between modes, and the current source output must be off (MODE ON indicator unlit) in order to change ranges.

The limit clamp function for DC output current applies to the modulated current as well protecting your laser in any mode. To accomplish setting the current source limit, use the (PARAMETER) SELECT push button LIM I. Press the (PARAMETER) SET push button and rotate the adjust knob. Set the limit to 1750 mA. Once the (PARAMETER) SET push button is released, the new parameter value is stored in non-volatile memory.

When the laser current limit is reached, the CURRENT LIMIT error indicator flashes. The current limit setting is independent of the voltage drop of the device connected to the laser output, and therefore, no dummy load is required for precise adjustment of the current limit. Furthermore, since the current limit circuitry is fully independent of the main current control, the current limit can be adjusted safely, even while the current source output is active.

Now you are ready to modulate the laser injection current. To enable the Current Source output, press the push button labeled (MODE) OUTPUT. The accompanying LED labeled ON will illuminate indicating that the laser current source's output is enabled. The instrument will drive the current source to the value set by the corresponding MODE setpoint. Turn on the function generator (modulation source) to inject the modulation signal.

To disable the output, press the OUTPUT push button again. When the LDX-3232 current output is off, an internal short is placed across the output. This short will prevent the modulation signal from reaching the LED in our example experiment. Thus, it is safe to disconnect the test device (LED) when the LDX-3232's output is off, regardless of the presence of the modulation signal.

CHAPTER 6

CALIBRATION AND TROUBLESHOOTING

This chapter describes calibration of your LDX-3232 Series Current Source. Descriptions of the required test instruments, calibration conditions, and the detailed procedures for calibration of the instrument's Laser Diode Current Source are included. A troubleshooting guide is also offered for some of the more common failure symptoms. This chapter is divided into three major sections, local (front panel) calibration, remote (through the GPIB Interface) calibration, and a troubleshooting guide.

Calibration Overview

There are several calibrations to be performed to completely calibrate your LDX-3232 Current Source. The Laser Diode Current Source calibration consists of calibrating the current source in both ranges and both modes (low and high bandwidth), calibrating the photodiode monitor feedback ammeter and finally the forward voltage measurement. The current limits are calibrated internally by the instrument as part of the calibration process.

Your LDX-3232 Current Source can be calibrated with the case closed. It should be calibrated every 12 months or whenever performance verification indicates that calibration is necessary, such as differences between setpoint and measurement display values that exceed the accuracy specification. Calibrate the instrument under laboratory conditions. We recommend calibration at 23°C ± 1.0°C. When necessary, however, the LDX-3232 Current Source may be calibrated at its intended use temperature if this is within the specified operating temperature range of 0 to 40°C.

Finally, the LDX-3232 Current Source should be allowed to warm up for at least one hour before calibration.

Recommended Equipment

Recommended test equipment for calibrating the LDX-3232 Current Source is listed in Table 6.1. Equipment other than that shown in the table may be used if the specifications meet or exceed those listed.

Table 6.1 Recommended Test Equipment

Description	Manufacturer/Model	Specification
DMM	HP 3457A	DC Amps (@ 1.0 A): ±0.02% Resistance (@ 10 Ω): ±0.02% 0.1 µA or 0.1 mV resolution

It will be necessary to connect various loads and circuits to the outputs of each current source for the calibration procedure. A schematic is shown in Figure 6.1 for the photodiode calibration circuit with the required components listed in Table 6.2. Also, the devices required for other calibration loads are listed in Table 6.2.

Table 6.2 Required Calibration Components

Laser Current Source Calibration	
Current Source Calibration, all models	10 Ω, 20 W resistor, low TCR
Voltage Measurement Calibration	15 Ω, 5 W resistor, low TCR
PD Monitor Calibration (See Schematic in Figure 6.1)	
PD Calibration Circuit R1 R2 R4 R3 U1	 49 Ω resistor, 1%, 1/4 W 100 Ω resistor, 1%, 1/4 W 1.0 MΩ resistor, 1%, 1/4 W 5 Ω, 1%, 10W TIL 117 opto isolator

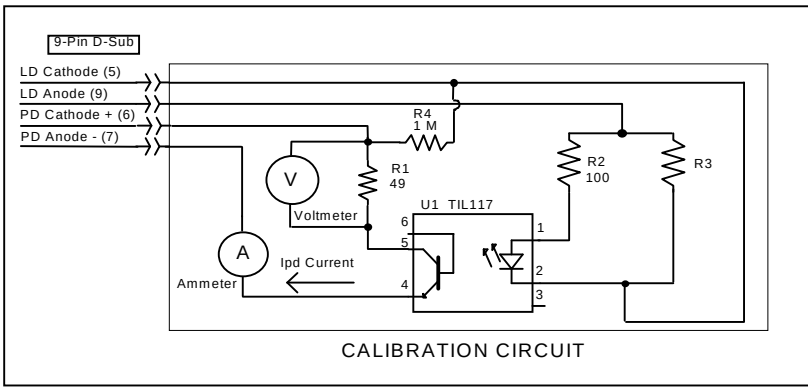


Figure 6.1 I_{PD} Calibration Circuit

Local Calibration of the LDX-3232 Current Source

There are three calibration adjustments required for the LASER current source of the LDX-3232 Current Source. They are calibration of the constant current source for both bandwidths and ranges, calibration of the laser voltage measurement, and calibration of the constant light power (I_{PD}) feedback circuits.

The LDX-3232 Current Source implements a two-point calibration for the Laser current source. Two currents (approximately 80% and 20% of FS) are applied to a test load, and the resulting actual currents are fed back (by the user) to the Current Source. The Laser Current Source calibration program uses the two sets of data to calculate new calibration constants. These calibration constants are used to set the actual current output of the current source.

Current Source Calibration

The following procedure is for calibrating each range of the current source. Calibration must be performed on both bandwidth modes. A total of four calibrations will be performed on the current source. Start with the low range, low bandwidth mode. Configure the Laser Current Source in the following state:

Function	State
MODE	I (constant current low bandwidth)
RANGE	low (lowest per instrument model)
CURRENT LIMIT	90% of FS (full scale of range)
SETPOINT	80% of FS

a. Measure and record the resistance of a 1Ω, 20 W resistor (A 4-wire [Kelvin] resistance measurement is recommended.) Connect the load resistor across the LASER output terminals (Laser Anode and Laser Cathode) on the 9 pin connector of the rear panel.

b. Connect the calibrated DMM across the load resistor. Configure the multimeter to measure voltage in volts. You will be calculating the actual Laser current in the following manner using Ohm's Law.

I = V/ R

--where V is the accurately measured voltage across the resistor, and R is the accurately measured load resistance in Ohms. I is the actual Laser current in Amps.

Note: Check the current measuring range of your multimeter. You may be able to measure Laser Output current in mA by connecting the meter directly to the outputs of the Laser Current Source.

c. Press the (MODE) ON switch to turn the current source output on. The output must be on in order to enter the LASER I calibration mode.

d. Enter the LASER I calibration mode by pushing the (GPIB) LOCAL and (DISPLAY) SELECT switches at the same time. The display will blank and the Current Source will drive the current output to the setpoint and the Display will indicate output current in mA.

e. Calculate the actual current through the load as described in step b. Press and hold in the (PARAMETER) SET switch and turn the adjust knob until the display indicates the calculated actual current.

f. Release the (PARAMETER) SET switch. After the (PARAMETER) SET switch is released, the Current Source will drive the current output to about 25% of the first calibration setpoint.

g. Calculate the measured current again through the load resistor.

h. Press and hold in the (PARAMETER) SET switch and turn the adjust knob until the display indicates the actual current as calculated in step g.

i. Release the (PARAMETER) SET switch to accept the second calibration point. After the (PARAMETER) SET switch is released, the Current Source will calculate the calibration constants and store them to nonvolatile memory. In low bandwidth calibration mode, the LDX-3232 Series Current Source will also perform current limit calibration, indicated by the CURRENT LIMIT LED flashing.

j. Turn the current source output off. Change the Mode to I_{HBW} (high bandwidth constant current mode). Repeat the calibration procedure as described above.

k. Change the output range to high range and repeat the calibration procedure as described above.

I_{PD} Current Calibration

The following procedure is for calibrating the LASER I_{PD} (PD monitor) setpoint and measurement. This procedure calibrates the feedback circuits for constant I_{PD} and constant P_{PD} modes. When these values are reached and are stable, the user enters the actual value of the monitor current, measured with a DMM. The

LDX-3232 Series Current Source then automatically calibrates the LASER feedback circuits.

Configure the Current Source in the following manner for the Laser Current Source calibration:

Function	State
MODE	P (constant power)
CAL PD	set equal to zero
CURRENT LIMIT	90% of FS (full scale of range)
I_{PD} SETPOINT	80% of FS

a. With the LASER output off, connect a calibrated ammeter to the PD Anode output of the Laser Current Source output connector (9 pin on rear panel), and connect the circuit of Figure 6.1 to the LASER and PD outputs with the correct load resistor for the Current Source model you are calibrating (See Table 6.2).

Note: If a precision ammeter is not available, use a zero-Ohm jumper in place of the ammeter. Then, place a calibrated DMM (with 0.1 mV resolution) to measure the voltage across the resistor, R1, as shown in Figure 6.1. Calculate the current in the following steps by using Ohm's Law:

$I = V/ R$

--where V is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the actual photodiode current to be measured by the LDX-3232 Current Source. (A 4-wire [Kelvin] resistance measurement is recommended.)

b. Press the (MODE) ON switch to turn the current source output on. Verify proper operation, i.e. the I_{PD} measurement (via DMM) and setpoint should be close, and the unit should not be in current limit.

c. Press the (GPIB) LOCAL and FINE switches at the same time to place the Current Source in its I_{PD} Current Calibration mode.

After a few seconds the display will show the I_{PD} setpoint value.

d. After the value on the display is stable (has not changed by more than one digit for several seconds) the LDX-3232 Current Source is ready for the actual I_{PD} value to be entered.

Press and hold in the (PARAMETER) SET switch and turn the adjust knob until the display shows the actual monitor current, as shown on the calibrated ammeter (or the calculated I_{PD} value from Step a).

e. Release the (PARAMETER) SET switch to store the first calibration value. The Current Source will then set the second calibration current, approximately one-fourth (1/4) of the original current. (For example, if the first calibration setpoint was 4000 µA, the second setpoint will be about 1000 µA.)

f. Press and hold in the (PARAMETER) SET switch and turn the adjust knob until the display indicates the actual current as measured by the ammeter or as calculated.

g. Release the (PARAMETER) SET switch to accept the second calibration point. After the (PARAMETER) SET switch is released, the LDX-3232 Series Current Source will calculate the calibration constants and store them to nonvolatile memory.

Laser Forward Voltage Measurement Calibration

The following procedure is for calibrating the LASER voltage measurement.

Configure the Current Source in the following manner for the Laser Current Source Voltage calibration:

Function	State
LASER MODE	I (constant current low bandwidth)
RANGE	2000 mA
CURRENT LIMIT	Set to FS (full scale of range)
I SETPOINT	800 mA

a. With the current source output off, connect a calibrated voltmeter, in parallel with a resistor (15 Ω, 5 W), to the LASER output (Laser Anode and Laser Cathode) on the rear panel of the Current Source.

b. Press the (MODE) ON switch to turn the current source output on. The current source output must be on in order to enter the LDV calibration mode.

c. Enter the LASER V calibration mode by pushing the (GPIB) LOCAL and RANGE switches at the same time. The display will blank and the Current Source will drive the LASER current output to the respective setpoint and the display will indicate forward voltage in Volts.

d. Enter the measured voltage (in volts). Press and hold in the (PARAMETER) SET switch and turn the adjust knob until the display indicates the measured voltage.

e. Once the actual voltage value is entered, the Current Source will set the current to approximately one-fourth (1/4) of the original value. It will then expect the second calibration voltage point.

f. Input the second actual (measured) LASER forward voltage as in Step d.

g. Once the second actual voltage value is entered, the Current Source will store the new calibration constants.

This ends the section on front panel calibration of your LDX-3232 Current Source. The next section discusses calibration through the GPIB/IEEE488 interface.

Remote Calibration of the LDX-3232 Current Source

The LDX-3232 Current Sources can be calibrated remotely via the GPIB Interface. All of the required calibration commands are listed in Table 4.1 in Chapter 4. The procedures below are general guidelines for writing a program to calibrate your instrument.

Note: The operation complete flag (bit 0 of the Standard Event Status Register) may be used to trigger a service request. This type of interrupt is enabled by setting bit 0 of the Service Request Enable register (via the `*ESE` command) and bit 5 of the Service Request Enable register (via the `*SRE` command). Service request (SRQ) handling depends on your GPIB hardware. Refer to your GPIB user's manual for details.

After a calibration value is entered, the `*OPC?` query may be used to determine when the calibration sequence is done. However, the `*OPC`, `*WAI` command, or `*OPC?` query should not be issued until after the expected calibration value is entered, or the system will "hang". This happens because the LDX-3232 Current Source will wait indefinitely for an input, yet not allow any input until the calibration is finished.

Current Source Calibration

There are three calibration adjustments required for the LDX-3232 Current Source. They are calibration of the constant current source for both bandwidths and ranges, calibration of the laser voltage measurement, and calibration of the constant light power (I_{PD}) feedback circuits.

The LDX-3232 Current Source implements a two-point calibration for the current source. Two currents (approximately 20% and 80% of FS) are applied to a test load, and the resulting actual currents are fed back (by the user) to the current source. The laser current source calibration program uses the two sets of data to calculate new calibration constants. These calibration constants are used to set the actual current of the current source.

The following procedure is for calibrating each range of the current source. Start with the low range. After calibration is complete in this range, switch to the high range and repeat the procedure.

Configure the current source in the following manner for the laser current source calibration:

Function	State	GPIB COMMAND
LASER MODE	I (constant current low bandwidth)	`LAS:MODE:ILBW`
RANGE	Low (lowest per instrument model)	`LAS:RAN x`
LIMIT	90% of FS (full scale of range)	`LAS:LIM:Ix`
SETPOINT	80% of FS	`LAS:LDI`

a. Measure and record the resistance of a 1 Ω, 20 W resistor. (A 4-wire [Kelvin] resistance measurement is recommended.) Connect the load resistor across the LASER output terminals (Laser Anode and Laser Cathode) on the 9 pin connector of the rear panel.

b. Connect the calibrated DMM across the load resistor. Configure the multimeter to measure voltage in volts. You will be calculating the actual Laser current in the following manner using Ohm's Law.

I = V/ R

--where V is the accurately measured voltage across the resistor, and R is the accurately measured load resistance in Ohms. I is the actual Laser current in Amps.

c. The current source output must be on in order to enter the LASER I calibration mode. Enter the `LAS:OUTPUT ON` command to turn the current source output on.

d. Enter the LASER I calibration mode by issuing the `LAS:CAL:LDI` command. The display will indicate a current in mA.

e. Input the first actual (measured) output current (as an `<nrf value>`) via the `LAS:LDI <nrf value>` command.

If this value is to be measured and entered remotely via a GPIB controlled DMM, for example, the measured value of the current should not be entered until the LDX-3232 Series Current Source is ready to receive it. The Current Source will be ready to receive the new measured value when, after a `LAS:CAL:LDI?` query is sent, the response from the Current Source is "1".

f. Once the newly measured I value is entered via the `LAS:LDI` command, the Current Source will apply a new current equal to about 25% of the previous set current.

g. Input the second actual (measured) output current (as an `<nrf value>`) as in Step e.

h. Once the second actual I value is entered via the `LAS:LDI` command, the new calibration constants will be calculated and stored into non-volatile memory. In low bandwidth calibration mode, the LDX-3232 Current Source will also perform current limit calibration as indicated by the CURRENT LIMIT LED flashing. The `OPC?` query may be used (after the `LAS:LDI` value is sent) to determine when the calibration is completed. Or, wait about two seconds before continuing with other GPIB commands.

i. Turn the current source output off. Change the Mode to I_{HBW} (high bandwidth constant current mode) with the `LAS:IHBW` command. Repeat the calibration procedure as described above.

I_{PD} Current Calibration

The following procedure is for calibration the LASER I_{PD} constant current source. This procedure calibrates the feedback circuits for constant I_{PD} and constant P_{PD} modes. When these values are reached and are stable, the user enters the actual value of the current, as measured by an external DMM. The LDX-3232 Current Source then automatically calibrates the LASER feedback circuits.

Configure the current source in the following manner for the laser current source calibration:

Function	State	GPIB COMMAND
LASER MODE	I (constant current low bandwidth)	`LAS:MODE:ILBW`
RANGE	Low (lowest per instrument model)	`LAS:RAN x`
LIMIT	90% of FS (full scale of range)	`LAS:LIM:Ix`
I_{PD} SETPOINT	80% of FS	`LAS:LDI`

a. With the LASER output off, connect a calibrated ammeter to the PD Anode output of the Laser Current Source output connector (9 pin on rear panel), and connect the circuit of Figure 6.1 to the LASER and PD outputs with the correct load resistor for the Current Source model you are calibrating (See Table 6.2).

b. Enter the `LAS:OUT ON` command to turn the LASER output on. Verify proper operation, i.e. the IPD output should be close to the setpoint, and the unit should not be in current limit (read the limit status via the `LAS:COND?` query, bit 0).

c. Enter the `LAS:CAL:MDI` command to place the Current Source in its LASER Current Calibration mode. The Current Source will increase the laser current output until the current at the PD monitor (I_{PD}) inputs equals the targeted setpoint.

d. After a few seconds, the Current Source will be ready for the actual I_{PD} current to be entered via the `LAS:MDI <nrf value>` command. The measured value of the current should not be entered until the Current Source is ready to receive it. The Current Source will be ready to receive the current value when, after a `LAS:CAL:MDI?` query is sent, the response from the Current Source is "1".

e. Once the actual I_{PD} value is entered via the `LAS:MDI <nrf value>` command, the Current Source will store the new calibration value. It will then set the output to approximately one-fourth (1/4) of the original current. (For example, if the first calibration setpoint was 4000 µA, the second setpoint will be 1000 µA.) Then, it will be ready to receive the second calibration value.

f. Input the second actual (measured) monitor diode current (as an `<nrf value>`) as in Step d.

g. Once the second actual IPD value is entered via the `LAS:MDI` command, the new calibration constants will be calculated and stored into non-volatile memory. The `OPC?` query may be used (after the `LAS:MDI` value is sent) to determine when the calibration is completed. Or, wait about two seconds before continuing with other GPIB commands.

Laser Forward Voltage Measurement Calibration

The following procedure is for calibrating the LASER voltage measurement.

Configure the current source in the following manner for the laser current source voltage calibration:

Function	State	GPIB Command
LASER MODE	I (constant current low bandwidth)	`LAS:MODE:ILBW`
RANGE	2000 mA	`LAS:RANGE1`
CURRENT LIMIT	Set to FS (full scale of range)	`LAS:LIM:Ix`
I SETPOINT	400 mA	`LAS:LDI 400`

a. With the LASER output off, connect a calibrated voltmeter, in parallel with a resistor (15 Ω, 5 W), to the LASER output (Laser Anode and Laser Cathode) on the rear panel of the Current Source.

b. The current source output must be on in order to enter the LDV calibration mode. Enter the `LAS:OUT ON` command to turn the current source output on.

c. Enter the `LAS:CAL:LDV` command to place the Current Source in its LASER Voltage Calibration mode.

d. Enter the measured voltage (in volts) via the `LAS:LDV <nrf value>` command. The measured value of the voltage should not be entered until the LDX-3232 Current Source is ready to receive it. The current source will be ready to receive the voltage value when, after a `LAS:CAL:LDV?` query is sent, the response from the Current Source is "1".

e. Once the actual voltage value is entered via the `LAS:LDV <nrf value>` command, the Current Source will set the current to approximately one-fourth (1/4) of the original value. It will then expect the second calibration voltage point.

f. Input the second actual (measured) LASER forward voltage (as an `<nrf value>`) as in Step d.

g. Once the second actual voltage value is entered via the `LAS:LDV` command, the Current Source will store the new calibration constants. The `OPC?` query may be used (after the `LAS:LDV` value is sent) to determine when the calibration is completed. Or, wait about two seconds before continuing with other GPIB commands.

Troubleshooting Guide

This section is a guide to troubleshooting the LDX-3232 Current Sources. Some of the more common symptoms are listed here, and the appropriate troubleshooting actions are given. We recommend that the user start at the beginning of this guide. Read the symptom descriptions, and follow the steps for the corrective actions that apply. If you encounter problems that are beyond the scope of this guide, contact your ILX Lightwave customer service representative.

Symptom	Corrective Actions
GENERAL	
LDX-3232 unit will not power up	Check AC power line voltage and power cord connection.
Power on, but display is frozen and switches don't operate	This may occur if the instrument loses power (AC line) briefly. turn the power switch off and on again to restart.
Displays E514 on power up on display	Hold (GPIB) LOCAL button, RANGE button and FINE button as you are powering up the instrument. This clears the laser board EEPROM, LLLLL will be displayed on the display; the laser current source must be recalibrated.
Instrument resets at power up or any LASER mode change	Hold (GPIB) LOCAL button, RANGE button and FINE button as you are powering up the instrument. This clears the laser board EEPROM, LLLLL will be displayed on the display; the laser current source must be recalibrated.
LASER CURRENT SOURCE	
Power on, but no current output	Check interlock pins on LASER input connector on instrument rear panel; these pins must be shorted either directly or though a switch. If OPEN CIRCUIT indicator is lit, check the load connections and then try again. Check the OUTPUT ON switch, the corresponding LED should be lit.
Output current at limit; can't be lowered	If POWER mode is used, check the monitor diode (feedback) connections; try reversing the polarity of the monitor photodiode; also check the photodiode bias adjustment on the rear panel. If in I or I_{HBW} mode, check the current setpoint and I LIMIT setting; setting the output below the limit may require several turns of the adjust know if the setpoint is much greater than the desired limit setting.
Output goes off intermittently	Check the interlock circuit; an intermittent interlock will turn the output off. Check that the AC power cord connection is secure; power line drop-outs may reset the unit and when power is restored, the output will be off.

Symptom	Corrective Actions
Unable to adjust output	Check the I LIMIT parameter for the output range in use, see that it is set above 0 mA.
Power mode operation has high output current, but little or no power measured	Check back panel PD BIAS; if set too low, may act as an open feedback loop; if in doubt, set the PD BIAS to mid range (2.5 V)
Output exceeds power limit	The “power limit” is not a hardware limit. It only serves as a warning that the power measurement has exceeded the limit setpoint. Normally this limit will cause the output to shut off. This feature can be defeated via the LAS:ENABLE:OUTOFF command.
Open circuit error occurs during calibration	Check load connections; check that measuring meter does not auto-range (use non-auto-ranging modes).
Calibration is aborted unintentionally	Calibration modes will be aborted if an open circuit is detected.
VOLTAGE LIMIT indicator blinks	This indicates a voltage limit error; check laser connections. A high impedance may cause this condition.
Open circuit error E503 or voltage limit error E505 prevents output from reaching desired value	The LDX-3232 instruments have an adjustable laser compliance voltage. Check to see if the LASER voltage limit setting is too low (Chapter 2); check laser connections.

Error Messages

In the event of a hardware error condition, error messages will be displayed on the display. In most cases, the error message will appear for three seconds. In some cases the error code display will remain until the user changes display modes. In the case of multiple error messages, the display may sequentially show each message for three seconds. In addition to the hardware errors, GPIB errors may be read via the ERR? query. Table 3.4 lists the numerical error ranges by function. Table 3.5 contains all of the error messages that may be generated. Not all of these messages may appear on the front panel displays. Some refer to GPIB activities only.

In remote operation, the errors can be read by issuing the ERR? query. When this is done, all of the error messages that are resident in the error queue are returned (up to 10 may be stored). Reading the error queue via GPIB clears the error queue.

Table 6.3 Error Code Classifications

Error Code Range	Area of Operation
E-001 to E-099	Internal Program Errors
E-100 to E-199	Parser Errors
E-200 to E-299	Execution Control Errors
E-300 to E-399	GPIB Errors
E-500 to E-599	LASER Control Errors

Table 6.4 LDX-3232 Series Error Codes

Error Code	Explanation
E-001	Memory allocation failure
E-103	<DEFINITE LENGTH ARBITRARY BLOCK PROGRAM DATA> length too long
E-104	<NON-DECIMAL NUMERIC PROGRAM DATA> type not defined
E-105	<DECIMAL PROGRAM DATA> exponent not valid
E-106	<DECIMAL PROGRAM DATA> digit expected
E-123	Command not found
E-124	<program mnemonic> Lookup, failed because query/command type match failed
E-126	Too few or too many program data elements
E-201	<PROGRAM DATA> value out of range
E-202	<PROGRAM DATA> will not convert to valid type

Error Code	Explanation
E-203	Security violation, command is not available without clearance
E-205	<PROGRAM DATA> is not a Boolean value or word
E-207	<PROGRAM DATA> will not convert to an unsigned 16-bit value
E-209	<PROGRAM DATA> will not convert to an unsigned 32-bit value
E-210	<PROGRAM DATA> will not convert to a floating point value
E-211	<PROGRAM DATA> will not convert to a character value
E-213	<PROGRAM DATA> is incorrect block data length
E-214	<PROGRAM DATA> length exceeds maximum
E-302	Query error; device was addressed to talk, but GPIB controller failed to read all of the <RESPONSE MESSAGE>
E-501	LASER interlock disabled output
E-503	LASER open circuit disabled output
E-504	LASER current limit disabled output
E-505	LASER voltage limit disabled output
E-507	LASER power limit disabled output
E-510	LASER out of tolerance disabled output
E-511	LASER control error disabled output
E-512	Analog section status is all 1's or all 0's (power down)
E-513	Serial EEPROM checksum error
E-515	Laser output must be off to change ranges
E-516	Incorrect configuration for calibration sequence to start
E-519	Setting a measurement is only valid during the calibration phase for that measurement; user has tried to calibrate a measurement without first entering the required calibration mode.